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# SCIENCE

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## THE EXPLANATION OF THE COLLOIDAL BEHAVIOR OF PROTEINS[1]

I

THIS year's Pasteur lecture coincides with the commemoration of the hundredth anniversary of Pasteur's birth. The application of Pasteur's ideas and discoveries has benefited humanity to such an extent that they have become part of the consciousness of civilized mankind. What is, perhaps, less widely understood is the fact that Pasteur changed the method of medical research. In the study of infectious diseases Pasteur substituted for the method of hit or miss (with the chances infinitely in favor of missing) the method of a definitely oriented search which never fails to give results when properly applied. Thousands of physicians had studied infectious diseases before Pasteur, but they tried to solve their problem by starting from observations of the symptoms of some special disease. This led to no result for the simple reason that without knowing beforehand for what to look—or, in other words, without knowing the general cause of infectious diseases—it was impossible to discover the cause of any special infectious process. Pasteur reversed this method by his discovery of the action and omnipresence of microorganisms, leaving it to the medical men to look for the special agency in the individual cases.

There is little doubt that the old empiricism, still in vogue in some other fields of medicine and in the physiological sciences, must be replaced by the more rationalistic method of Pasteur of knowing the general fundamental principles before attempting to explain the more special phenomena, since, unless we follow this method, we never know which of

[1] Pasteur Lecture delivered before the Institute of Medicine of Chicago on November 24, 1922.

the details we observe are significant and which are negligible.

## II

Living matter is essentially colloidal in character and we can not well conceive of an organism consisting exclusively of crystalloidal matter. This fact suggests that life phenomena depend upon or are intrinsically linked with certain characteristics of colloidal behavior. It is, therefore, natural that a systematic study of the nature of special life phenomena should be preceded by a scientific theory of colloidal behavior. By a scientific theory, however, we do not understand speculations or guesses built on qualitative experiments or no experiments at all, but the derivation of the results from a rationalistic, mathematical formula which permits us to calculate, with an adequate degree of accuracy, the quantitative measurements of colloidal behavior.

Proteins are amphoteric electrolytes which are capable of forming salts with either alkalies or acids. With alkalies they form salts like Na proteinate, Ca proteinate, etc., and with acids they form salts like protein chloride, protein sulfate, etc. Whether they do the one or the other depends on the hydrogen ion concentration of the protein solution. There is one definite hydrogen ion concentration at which a protein can combine practically with neither acid nor alkali, and this hydrogen ion concentration, which may be different for different proteins, is called the isoelectric point. The isoelectric point is (in terms of Sörensen's logarithmic symbol) for gelatin and casein at $p_H$ 4.7; for crystalline egg albumin at $p_H$ 4.8. Gelatin can combine with acid only or practically only when the $p_H$ is less than 4.7 and with alkali only or practically only when the $p_H$ is higher than 4.7. Or in other words, when a salt, *e. g.*, $NiCl_2$, is added to gelatin solutions of different $p_H$, Ni gelatinate can only be formed when the $p_H$ is greater than 4.7; and when $K_4Fe(CN)_6$ is added gelatin-$Fe(CN)_6$ can only be formed when the $p_H$ is less than 4.7. This can be shown by methods discussed in a recent book.[2]

2 Loeb, J.: "Proteins and the Theory of Colloidal Behavior," New York and London, 1922.

The proof that proteins combine stoichiometrically with acids and alkalies can be furnished by titration curves. For this purpose (and perhaps for work with proteins in general) it is necessary to use as standard material protein of the $p_H$ of the isoelectric point. We have seen that proteins combine with acids only at a $p_H$ below that of the isoelectric point, which for gelatin or casein is about $p_H$ 4.7 and for crystalline egg albumin 4.8. It happens that at a $p_H$ below 4.7 most of the weak dibasic and tribasic acids dissociate as monobasic acids. Thus $H_3PO_4$ dissociates into $H^+$ and the monovalent anion $H_2PO_4^-$. Hence if acids combine stoichiometrically with isoelectric protein, it should require exactly three times as many cc. of 0.1 N $H_3PO_4$ to bring a 1 per cent. solution of an isoelectric protein, *e. g.*, gelatin or crystalline egg albumin or casein, to the same hydrogen ion concentration, *e. g.*, $p_H$ 3.0, as it requires of 0.1 N HCl or $HNO_3$. Titration experiments show that this is the case. Furthermore, since $H_2SO_4$ is a strong acid, splitting off both hydrogen ions even at a $p_H$ below 4.7, the same number of cc. of 0.1 N $H_2SO_4$ as of HCl should be required to bring 1 gm. of isoelectric protein in 100 cc. of solution to the same $p_H$, *e. g.*, 3.0, and this was found also to be true.

Fig. 1 gives the titration curves for crystalline egg albumin for four acids, HCl, $H_2SO_4$, $H_3PO_4$, and oxalic acid. One gram of isoelectric albumin was in 100 cc. $H_2O$ containing

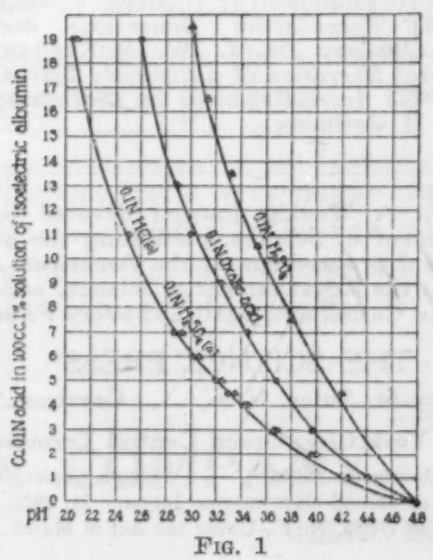


FIG. 1

various cc. of 0.1 N acid. These cc. of 0.1 N acid in 100 cc. solution are the ordinates of the curves in Fig. 1. The abscissæ are the $p_H$ to which the protein solution was brought by the addition of acid. It takes always exactly three times as many cc. of 0.1 N $H_3PO_4$ as it takes cc. of 0.1 N HCl or $H_2SO_4$ to bring 1 gm. of isoelectric albumin in 100 cc. solution to the same $p_H$. In order to bring the 1 per cent. solution of originally isoelectric albumin to $p_H$ 3.2, 5 cc. of 0.1 N HCl or $H_2SO_4$ and 15 cc. of 0.1 N $H_3PO_4$ must be contained in 100 cc. of the solution. To bring the albumin to $p_H$ 3.4, 4 cc. of 0.1 N HCl or $H_2SO_4$ and 12 cc. of 0.1 N $H_3PO_4$ must be contained in the solution, and so on.

Oxalic acid is, according to Hildebrand, a monobasic acid at a $p_H$ of 3.0 or below, but begins to split off the second hydrogen ion in increasing proportion above $p_H$ 3.0. The titration curves show that about twice as many cc. of 0.1 N oxalic acid as 0.1 N HCl are required to bring the 1 per cent. solution of isoelectric albumin to the same $p_H$ below 3.0, while it takes less than twice as many cc. of 0.1 N oxalic acid as 0.1 N HCl to bring the albumin solution to the same $p_H$ if the $p_H$ is above 3.0.

It can be shown in the same way with the aid of titration curves that isoelectric albumin combines with alkalies in the same stoichiometrical way as any acid, *e. g.*, acetic acid, would combine with the same alkalies. If the cc. of 0.1 N KOH, NaOH, $Ca(OH)_2$, or $Ba(OH)_2$ in 100 cc. solution required to bring a 1 per cent. solution of isoelectric protein to the same $p_H$ are plotted as ordinates over the $p_H$ of the protein solution as abscissæ, it is found that the values for all four alkalies fall on one curve as they should if the combination occurred strictly stoichiometrically.

The same stoichiometrical results were obtained also with casein and gelatin by the writer, and with edestin and serum globulin by Hitchcock. There is little doubt that they will be obtained in the case of all proteins. It follows from this that proteins react with acids and alkalies in the same way as do amphoteric crystalloids like amino-acids. If the methods for measuring the hydrogen ion concentrations of protein solutions had been employed by the colloid chemists nobody would have thought of suggesting that proteins react with acids and alkalies according to the empirical adsorption formula of Freundlich instead of stoichiometrically.

The purely chemical character of the combination of proteins with hydrochloric acid can also be demonstrated by measuring the chlorine ion concentration of the solutions of protein chloride. When HCl is added to $NH_3$ (according to Werner) the H ions of the HCl are attracted to the nitrogen of the ammonia, while the Cl ions remain unaltered. The same type of reaction occurs when HCl is added to a solution of isoelectric gelatin. This was proven by measurements of the $p_{Cl}$ of solutions of gelatin chloride. Different cc. of 0.1 N HCl were contained in 100 cc. of 1 per cent. solutions of originally isoelectric gelatin and the $p_H$ and $p_{Cl}$ of the solutions were measured, the $p_H$ with the hydrogen electrode and the $p_{Cl}$ with the calomel electrode. It was found that the $p_{Cl}$ was the same as if no gelatin had been present while the $p_H$ was, of course, higher; thus showing that part of the hydrogen combines with the $NH_2$ and NH groups of the protein molecule while the Cl remains free (Table I). Dr. Hitchcock has obtained similar results with crystalline egg albumin, edestin, casein, and serum globulin, by using a silver chloride electrode, so that it is possible to state that these results are true for most if not all proteins.

TABLE I

| Cubic centimeters of 0.1 N HCl in 100 cc. solution | Solution containing no gelatin | | Solution containing 1 gm. of isoelectric gelatin in 100 cc. | |
|---|---|---|---|---|
| | $p_H$ | $p_{Cl}$ | $p_H$ | $p_{Cl}$ |
| 2 | 2.72 | 2.72 | 4.2 | 2.68 |
| 3 | 2.52 | 2.54 | 4.0 | 2.53 |
| 4 | 2.41 | 2.39 | ..... | ..... |
| 5 | 2.31 | 2.29 | 3.60 | 2.33 |
| 6 | 2.24 | 2.26 | 3.41 | 2.25 |
| 7 | 2.16 | 2.18 | 3.23 | 2.18 |
| 8 | 2.11 | 2.12 | 3.07 | 2.11 |
| 10 | 2.01 | 2.01 | 2.78 | 2.025 |
| 15 | 1.85 | 1.85 | 2.30 | 1.845 |
| 20 | 1.72 | 1.76 | 2.06 | 1.76 |
| 30 | 1.55 | 1.59 | 1.78 | 1.60 |
| 40 | 1.43 | 1.47 | 1.61 | 1.47 |

The titration curves prove another fact, namely, that the salts of proteins are strongly hydrolyzed. When we add acid, *e. g.*, HCl, to isoelectric protein, part of the acid combines with the protein giving rise to protein chloride, while the rest of the acid remains free. There is then an equilibrium between free HCl, protein chloride, and non-ionogenic (or isoelectric) protein. The more acid is added to originally isoelectric protein, the more protein chloride is formed until finally all the protein exists in the form of protein chloride. It is possible to find out from the $p_H$ measurements how much of the acid added is free and by deducting this value we know how much is in combination with the protein. By saturating the protein with acid the combining weight of a protein with acid can be found. Hitchcock found in this way that the combining weight of gelatin is about 1090.

III

The colloidal behavior of proteins shows itself in a peculiar effect of electrolytes—acids, alkalies or salts—on such properties as the swelling of gels or the osmotic pressure or viscosity of protein solutions. All these properties, swelling, osmotic pressure, viscosity, are affected by electrolytes in a very similar way; suggesting that all are due to the same cause. We shall see that by giving the explanation for one of these properties, osmotic pressure, we shall by implication give the explanation for all of them.

Measurements of the osmotic pressure of solutions of a protein—gelatin, crystalline egg albumin, casein and edestin—were made with solutions containing 1 gm. dry weight of originally isoelectric protein in 100 cc. of solution; and the 100 cc. of solution included also varying concentrations of 0.1 N acid. These solutions were put into collodion bags suspended in water free from protein. The outside water was at the beginning of the experiment brought to the same $p_H$ as that of the protein solution, using always the same acid as that added to the protein. The measurements of the osmotic pressure were read after 18 hours when osmotic equilibrium was established. It was found that the osmotic pressure varied in a characteristic way with the $p_H$ of the protein solution and the valency of the anion of the acid used. This effect is shown in the curves in Fig. 2 which were obtained from gelatin solutions. But the curves are similar in the case of other proteins such as crystalline egg albumin, casein or edestin. These curves show that the osmotic pressure of a protein solution is a minimum at the isoelectric point, that it increases when little acid is added until a maximum is reached, and that on the further addition of acid the osmotic pressure is again diminished. They show, moreover, that only the valency and not the nature of the anion of the acid influences the osmotic pressure of a protein solution. We know from the titration curves that in the case of $H_3PO_4$ the anion in combination with the protein is not the trivalent $PO_4$ but the monovalent $H_2PO_4$; and the curves in Fig. 2 show that the influence of phosphoric acid and hydrochloric acid on the osmotic pressure is the same if measured for the same $p_H$ of the protein solution. Oxalic acid is a monobasic acid below $p_H$ 3.0 and we notice that the descending branch of the oxalic acid curve below $p_H$ 3.0 practically coincides with the descending branch of the HCl curve. The curve for the influence of $H_2SO_4$ is only about half as high as that for HCl and we know from the titration curves that the anion of protein sulfate is bivalent. It was found that all monobasic acids, *e. g.*, HBr, $HNO_3$, acetic acid, etc., and all weak dibasic or tribasic acids, *e. g.*,

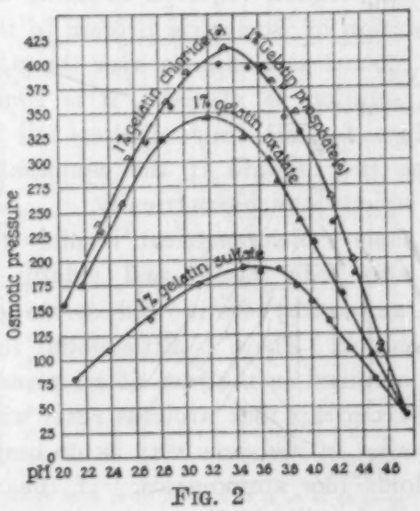


FIG. 2

tartaric, malic, citric, etc., which below $p_H$ 4.7 dissociate as monobasic acids, give osmotic pressure curves identical with those for HCl and $H_3PO_4$. We may, therefore, draw the conclusion that only the valency but not the nature of the acid influences the osmotic pressure of protein solutions, that all acids which are monobasic on the acid side of the isoelectric point of a protein influence its osmotic pressure in the same way, and that this influence is considerably greater than the influence of strong dibasic acids like $H_2SO_4$.

If alkali is added to a solution of isoelectric protein it can be shown that the addition of little alkali increases the osmotic pressure until a maximum is reached when the addition of more alkali depresses the osmotic pressure again. All alkalies with monobasic cation like Li, Na, K, $NH_4$, have the same effect at the same $p_H$, while alkalies and all dibasic cations like Ca or Ba act alike, the curve for the effect of the alkalies with divalent cation being only about half as high as that of the alkalies with monovalent cation.

A third fact (discovered by R. S. Lillie) is that the addition of salts to a solution of a protein salt always depresses the osmotic pressure.

The curves representing the influence of acids and salts on the osmotic pressure are almost identical or very similar to those representing the influence of the same acids and salts on swelling and viscosity. These results are specific for colloidal behavior and any theory of colloidal behavior will have to give not only a qualitative but a quantitative theory of these curves.

It was suggested by Zsigmondy that the influence of acid on osmotic pressure was due to an influence on the degree of dispersion of the protein in solution, but since the degree of dispersion can not be accurately measured, this suggestion is only a qualitative speculation. But it is of no use even as a qualitative speculation since it fails to account for the fact that viscosity and swelling are affected in a similar way as osmotic pressure. The correct explanation is as follows: When acid (or alkali) is added to a solution of an isoelectric protein, part or all of this is transformed into an ionizable protein salt according to the amount of acid added. This ionization of the protein causes the colloidal behavior on account of the inability of protein ions to diffuse through membranes which are easily permeable to crystalloidal ions, such as collodion or parchment membranes or the walls of capillaries or probably of all cells. Now it was shown by Donnan that whenever the diffusion of one type of ions such as colloidal ions is prevented by a membrane which is readily permeable to crystalloidal ions, an unequal distribution of the diffusible crystalloidal ions results on the opposite sides of the membrane. This unequal distribution of diffusible crystalloidal ions is the cause of the colloidal behavior of proteins.

## IV

When a collodion bag is filled with a solution of gelatin chloride of $p_H$ 3.0 and the bag is immersed in an aqueous solution of HCl also of $p_H$ 3.0 but free from protein, acid is driven from the protein solution into the outside aqueous solution free from protein. Donnan has shown thermodynamically that when osmotic equilibrium is established the products of the concentrations of each pair of oppositely charged diffusible ions (*e. g.*, H and Cl in the case of gelatin chlroide) are equal on the opposite sides of the membrane. Let $x$ be the molar concentration of the H and Cl ions on the outside, $y$ the molar concentration of the free H and Cl ions inside the protein solution, and $z$ the concentration of the Cl ions in combination with the protein; then equilibrium is defined by the following equation, first used by Procter and Wilson to explain the influence of acid on swelling,

$$x^2 = y(y + z) \qquad (1)$$

The first step in an attempt to explain the influence of acids, alkalies and salts on the osmotic pressure of protein solutions is to find out whether the variations in osmotic pressure under the influence of acids as shown in Fig. 2 are accompanied by corresponding differences in the concentration of diffusible ions inside and outside the protein solution and whether these differences can be calculated from Donnan's equilibrium equation (1).

The writer was able to show that this is true by making measurements of a property of protein solutions, which had received little if any attention in colloid chemistry, namely, the measurements of the membrane potentials existing between a protein solution and the surrounding aqueous solution at the time of osmotic equilibrium.

Donnan's equilibrium formula can be written in the form

$$\frac{x}{y} = \frac{y + z}{x}$$

where $\frac{x}{y}$ is the ratio of the molar concentration of the hydrogen ions outside to the concentration of the hydrogen ions inside, while $\frac{y + z}{x}$ is the ratio of the molar concentration of the chlorine ions inside to that outside. Donnan had shown that there should exist a potential difference between the inside and outside solutions, which at 24° C. should be equal to $59 \times \log \frac{x}{y}$ millivolts or $59 \times \log \frac{y + z}{x}$ millivolts. Since $p_H$ inside is $= -\log y$ and $p_H$ outside is $= -\log x$, $\log \frac{x}{y}$ is equal to $p_H$ inside minus $p_H$ outside. $p_H$ inside and $p_H$ outside can be determined directly with the aid of the hydrogen electrode; $\log \frac{y + z}{x}$ is equal to $p_{Cl}$ outside minus $p_{Cl}$ inside and this quantity can be measured directly by titration or with the silver chloride electrode.

On the other hand, the P.D. between the protein solution and the surrounding aqueous solution across a collodion membrane can be measured directly with the aid of a Compton electrometer and a pair of identical indifferent calomel electrodes (and saturated KCl). If the unequal distribution of diffusible crystalloidal ions (*e. g.*, H and Cl in the case of gelatin chloride) on the opposite sides of the membrane is really determined by the Donnan equilibrium, then the P.D. observed directly with the pair of identical calomel electrodes should be equal to the P.D. calculated in millivolts from the values $59 \times (p_H$ inside minus $p_H$ outside) or from $59 \times (p_{Cl}$ outside minus $p_{Cl}$ inside), where $p_{Cl}$ or $p_H$ may be obtained by titration or by the silver chloride or hydrogen electrodes respectively. The writer has made these measuremeents and found that when various quantities of acid are added to solutions of isoelectric protein—*e. g.*, crystalline egg albumin, or gelatin, or casein—the observed membrane potentials always agree with the membrane potentials calculated on the basis of Donnan's equation within one or two millivolts, *i. e.*, within the limits of accuracy of the measurements.

The net result of extensive measurements of membrane potentials was, first, that when a protein solution, enclosed in a collodion bag (impermeable to protein ions but permeable to crystalloidal ions), is in osmotic equilibrium with an outside aqueous solution, the concentrations of crystalloidal ions in the protein solution and in the outside aqueous solution are not the same; and second, that the difference in the two concentrations can be calculated from Donnan's equilibrium equation.

## V

We are now in a position to explain the osmotic pressure curves in Fig. 2. The colloid chemists would have taken it for granted that such curves were due to an influence of the acids on the state of dispersion or on some other real or imaginary colloidal property of proteins. Before we have a right to indulge in such speculations we must realize that these curves of observed osmotic pressure are not exclusively the expression of the osmotic pressure due to the protein particles, or protein molecules, and protein ions alone, but are also the result of the demonstrable unequal concentrations of the crystalloidal ions on the opposite sides of the membrane, caused by the establishment of a Donnan equilibrium. In other words, the observed osmotic pressure of a protein solution needs a correction due to the Donnan equilibrium before we can begin to speculate on the cause of the influence of acid on these curves, and it is our purpose to calculate the value of this correction.

We begin with the curve expressing the influence of HCl on the osmotic pressure of a 1 per

cent. solution of originally isoelectric gelatin and we consider the distribution of ions inside the protein solution and in the aqueous solution outside the collodion bag containing the protein solution at osmotic equilibrium. We also assume complete electrolytic dissociation of gelatin chloride as well as HCl. Let $a$ be the molar concentration of the protein molecules and ions, let $z$ be the molar concentration of the Cl ions in combination with the ionized protein, let $y$ be the molar concentration of the hydrogen ions of the free HCl inside the protein solution; the molar concentration of the Cl ions of this HCl is also $y$. In that case the osmotic pressure of the protein solution is determined by

$$a + 2y + z$$

From this must be deducted the osmotic pressure of the HCl of the outside aqueous solution. If $x$ is the molar concentration of the H ions of the outside solution, it is also the molar concentration of the Cl ions. Hence the observed osmotic pressure of a protein solution is determined by the following molar concentration,

$$a + 2y + z - 2x$$

Fig. 2 shows how this value varies with the $p_H$ of the protein solution (*i. e.*, $y$). In order to arrive at a theory concerning the influence of HCl on the osmotic pressure of protein solutions it is necessary to calculate the value of $2y + z - 2x$ and to deduct it from the observed osmotic pressure of the protein solution. The term $2y + z - 2x$ we will call the Donnan correction. In this term $y$ and $x$ can be calculated from the measurements of the $p_H$, $p_H$ inside being $-\log y$ and $p_H$ outside being $-\log x$. $z$ can be calculated from $x$ and $y$ with the aid of the Donnan equation (1)

$$z = \frac{(x + y)(x - y)}{y}$$

since we now know that $x$ and $y$ are determined by the Donnan equilibrium. If the value of $2y + z - 2x$ is calculated for different $p_H$ of a gelatin chloride solution (of the same concentration of originally isoelectric gelatin which in this case was 1 per cent.); and if from this value is calculated the osmotic pressure due to this excess of the molar concentration of crystalloidal ions inside the protein solution over that outside, it is found that the curve for the Donnan correction is almost identical with the curve for the observed osmotic pressure. In other words, it turns out that the increase in osmotic pressure of a 1 per cent. solution of originaly isoelectric gelatin upon the addition of little acid until a maximum is reached, and the diminution of osmotic pressure upon the addition of further acid are not due to any variation in the state of dispersion of the protein, or any other real or imaginary "colloidal" property of the protein, but purely to the fact that protein ions can not diffuse through the collodion membrane which is easily permeable to crystalloidal ions; as a consequence of which the molar concentration of the crystalloidal ions must always be greater inside the protein solution than outside. What varies with the $p_H$ of the gelatin solution is the quantity of the excess of $2y + z$ over $2x$. This follows from the Donnan equation (1) according to which

$$x = \sqrt{y^2 + yz} \text{ or } 2x = \sqrt{4y^2 + 4yz}$$

while

$$2y + z = \sqrt{4y^2 + 4yz + z^2}$$

Now it is obvious that

$$\sqrt{4y^2 + 4yz + z^2} > \sqrt{4y^2 + 4yz}$$

*i. e.*, the concentration of the crystalloidal ions inside the protein solution $2y + z$ is always greater than the concentration of the crystalloidal ions $2x$ outside, when $z$ is not 0 or $\infty$.

If we substitute for the term $2y + z - 2x$ of the Donnan correction the identical term

$$\sqrt{4y^2 + 4yz + z^2} - \sqrt{4y^2 + 4yz}$$

we can visualize why the osmotic pressure is a minimum at the isoelectric point, why it increases with the addition of little acid, reaching a maximum, and why it diminishes again with the addition of more acid.

At the isoelectric point no protein is ionized and $z$ being zero, the whole term

$$\sqrt{4y^2 + 4yz + z^2} - \sqrt{4y^2 + 4yz}$$

becomes zero. Hence at the isoelectric point the observed osmotic pressure is purely that due to the protein, which is very low on account of the high molecular weight of gelatin.

When little acid, *e. g.*, *H*Cl, is added to the solution of isoelectric gelatin, gelatin chloride is formed and some free acid remains, due to hydrolytic dissociation. Hence both $z$ (the concentration of Cl ions in combination with protein) and $y$ (the Cl ions of the free HCl existing through hydrolysis) increase, but $z$ increases at first more rapidly than $y$ and hence the excess of concentration of ions inside over that of ions outside increases until the greater part of protein is transformed into protein chloride, when the excess of crystalloidal ions inside over those outside reaches a maximum. From then on $z$ increases comparatively little while $y$ increases considerably with further addition of acid, so that $z$ becomes negligible in comparison with $y$. This explains why the Donnan correction becomes zero again when enough acid is added, and why the observed osmotic pressure becomes as low again as at the isoelectric point.

In the same way it can be shown why the addition of salt has only a depressing effect on the osmotic pressure. Let us assume that there is inside the bag a gelatin chloride solution of $p_H$ 3.0 to which NaCl is added. $z$ (the concentration of Cl ions in combination with the gelatin) will not increase with the addition of salt, while $y$ (the concentration of the Cl ions *not* in combination with gelatin) will increase. Hence with the increase in the concentration of the salt the value of

$$\sqrt{4y^2 + 4yz + z^2} - \sqrt{4y^2 + 4yz}$$

will become smaller, finally approaching zero.

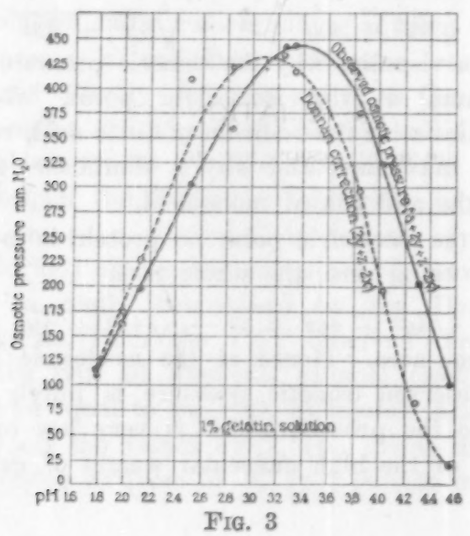


FIG. 3

When another salt than a chloride, *e. g.*, $NaNO_3$, is added to a solution of gelatin chloride, we may assume that the gelatin in solution is gelatin nitrate.

Fig. 3 gives a comparison of the curves for the observed osmotic pressure and for the Donnan correction. Both curves rise in a parallel way from the isoelectric point reaching a maximum which is 450 mm. $H_2O$ pressure in the case of the observed osmotic pressure and slightly lower in the case of the Donnan correction. The observed osmotic pressure should be higher than the Donnan correction by the osmotic pressure due to the protein solution itself. A difference exists in the values between $p_H$ 4.6 and 3.2 but disappears later, and this difference is in all probability the expression of value *a, i. e.*, the osmotic pressure due to the protein itself. The disappearance of this difference at $p_H$ below 3.2 is probably due to the fact that an error of one unit in the second decimal of the $p_H$ causes a considerable error in the calculations of $z$ which increases when the $p_H$ is too low.

Fig. 3 shows that when we correct the observed osmotic pressure for the Donnan effect it follows that the influence of the $p_H$ of the acid on the osmotic pressure is entirely or practically entirely due to the excess of the concentration of crystalloidal ions inside the membrane over that outside and that this excess is caused by the Donnan equilibrium. The osmotic pressure of the protein itself is either not altered at all by the addition of acid or if it is altered the effect is too small to be noticeable. There is then nothing left for the "dispersion theory" or for any other of the colloidal speculations to explain. These results were confirmed for crystalline egg albumin and casein by the writer and for edestin by Hitchcock. We now understand why only the valency and not the nature of the ion plays a rôle in the osmotic pressure of protein solutions. The equilibrium equation is one of the second degree when the ion with which the protein is in combination is monovalent while it is of the third degree when the ion is divalent. Only the valency of the ion and not its nature enters into the Donnan equation.

We can therefore summarize these results by

stating that the so-called colloidal behavior of protein solutions, as far as osmotic pressure is concerned, is merely the result of an equilibrium condition of classical chemistry which results in an excess of the concentration of crystalloidal ions inside the protein solution over that of an outside aqueous solution, when the two solutions are separated by a membrane which is permeable to crystalloidal ions but impermeable to protein ions. The colloidal behavior of proteins depends therefore entirely on the relative non-diffusibility of protein ions through membranes which are easily permeable to crystalloidal ions. Since the majority of membranes in plants and animals belong to this class, it can easily be surmised how great a rôle the proteins must play in the regulation of osmotic pressure in the body.

## VI

It remains to show briefly why swelling and viscosity of protein solutions are affected in a similar way by electrolytes as is the osmotic pressure. The answer is that we are dealing in both cases with the same fundamental property, namely, osmotic pressure.

In 1910 Procter made the ingenious suggestion that the swelling of gelatin might be an osmotic phenomenon and in subsequent papers he and J. A. Wilson put this theory on a quantitative basis by deriving it from the Donnan equilibrium. They showed that the swelling of a solid gel of gelatin in hydrochloric acid can be explained quantitatively on the basis of the Donnan equilibrium on the assumption that there exists an excess of concentration of crystalloidal ions inside (in this case H and Cl) over the concentration of the same ions outside, and that the excess of osmotic pressure inside the gel over that outside due to this Donnan effect accounts for that share of the swelling which is caused by the influence of the acid. The agreement of their calculated values with the observed values is excellent. The writer is inclined to consider Procter's theory of swelling and the proof of this theory by Procter and J. A. Wilson as the most brilliant contribution to the theory of colloidal behavior next in importance only to Donnan's theory of membrane equilibria. There was only one detail left by these authors, namely, to prove the existence of membrane potentials between the gel and the surrounding aqueous solution at equilibrium. The writer was able to fill this gap and to show that the observed P.D. between gel and surrounding aqueous solution can be calculated with a fair degree of accuracy from the value $p_H$ inside minus $p_H$ outside with the aid of Nernst's logarithmic formula.

## VII

It may seem strange that the influence of electrolytes on the viscosity of certain protein solutions should be explained in the same way, but this seems to be the case. According to Einstein's formula, the viscosity of an aqueous protein solution is a linear function of the relative volume of the solute occupied in the solution, as expressed in the formula

$$\eta = \eta_0(1 + 2.5\varphi)$$

where $\eta$ is the viscosity of the solution, $\eta_0$ that of pure water, and $\varphi$ the proportion of the volume of the solute to that of the solution. If, therefore, the addition of little acid to a 1 per cent. solution of isoelectric gelatin increases the viscosity of the solution until a maximum is reached and if the addition of more acid depresses the viscosity again, it follows that the addition of acid changes the relative volume occupied by the gelatin in water. This is only possible by water being absorbed by the protein and the question is how to account for this absorption of water by the protein under the influence of acid. Pauli assumed that the ionized protein surrounds itself with a jacket of water which is lacking in the non-ionized protein. If this were true, all the proteins and amino-acids should show such an influence of acid on the viscosity of their solutions. The writer found that no such influence exists in the case of amino-acids and at least one protein, namely, crystalline egg albumin; if Pauli's assumption were correct, there is no reason why crystalline egg albumin should not show the same influence of acid on viscosity which is found in the case of gelatin. The difference between gelatin and crystalline egg albumin is that the former sets to a solid gel

if the temperature is not too high while the latter does not. The formation of a continuous gel in the gelatin solution is preceded by the formation of submicroscopic aggregates which occlude water and which are capable of swelling and these aggregates or precursors of the continuous gel increase in size and number on standing. To test this idea the writer made experiments with suspensions of powdered gelatin in water and found that such suspensions of powdered gelatin had a much higher viscosity than a freshly prepared solution of gelatin. This was to be expected if the influence of acid on the viscosity of proteins is due to the swelling of submicroscopic particles of gel. It harmonizes with this fact that the viscosity of solutions of crystalline egg albumin is of a low order of magnitude, which was to be expected if solutions of crystalline egg albumin contain few or no micellæ. It was found, moreover, that the viscosity of suspensions of powdered gelatin increased under the influence of acid or alkali in the same way as did the swelling of jellies or the osmotic pressure of protein solutions. The viscosities were measured at 20° C. When the suspension of powdered gelatin was melted, it was found upon rapid cooling to 20° C. that the viscosity was considerably lower and that the influence of acid had almost disappeared. By these and a number of similar experiments it was possible to prove that the similarity between the influence of electrolytes on the viscosity of gelatin solution and the influence of electrolytes on osmotic pressure is due to the fact that the influence on viscosity in such cases is in reality an influence on the swelling of submicroscopic protein particles. This proof was made complete by showing that there exists a Donnan equilibrium between powdered particles of gelatin and a surrounding weak gelatin solution.

## VIII

It may not be amiss to illustrate by way of an example why it is that the neglect of measuring the hydrogen ion concentration of protein solutions necessarily leads into errors. In a paper published in 1921 by Kuhn,[3] it was intended to show that different acids of the same valency have different effects on the swelling of gelatin. In order to furnish such a proof it is necessary to start with isoelectric gelatin and to compare the effect of different acids on the swelling of this isoelectric gelatin at the same hydrogen ion concentration of the gel, since only in that case have the gels the same concentration of gelatin ions. Instead of starting with isoelectric gelatin or gelatin of a measured $p_H$, Kuhn failed to measure the $p_H$ of his gelatin, though it makes quite a difference whether acid is added to isoelectric gelatin or to gelatin at another $p_H$. Further, instead of measuring the $p_H$ of the gel with the hydrogen electrode, Kuhn calculated the hydrogen ion concentrations from Kohlrausch's tables as if acid had been added to water free from gelatin and as if the presence of the protein did not alter the hydrogen ion concentration. Our titration curves, however, show that when acid is added to isoelectric gelatin the hydrogen ion concentration is less than when acid is added to water free from protein. And finally, on account of the Donnan equilibrium the $p_H$ inside and outside the gel are entirely different; yet no mention is made of the Donnan equilibrium in the paper referred to. The hydrogen ion concentrations of protein solutions which were considered as equal by Kuhn were on account of all these errors entirely different, and it is quite natural that Kuhn came to the conclusion that different monobasic acids have different effects on swelling, since it would have been a miracle if with his faulty methods he had ever compared two acids of the same $p_H$. The same criticism applies to all the older experiments on the influence of electrolytes on swelling in which the authors reached the conclusions that different anions of the same valency have different effects on swelling (Hofmeister series). In all these experiments the authors failed to measure the $p_H$ of their gels and erroneously attributed effects due to differences of the $p_H$ of the gels to the difference in the nature of the anion.

[3] Kuhn, A.: *Kolloidchem. Beihefte*, 1921, xiv, 147.

## IX

We therefore come to the conclusion that the chemistry of proteins does not differ from the chemistry of crystalloids, and that proteins combine stoichiometrically with acids and alkalies forming protein salts which dissociate electrolytically. The enormously large protein ions and molecules can not diffuse freely through gels or many membranes which are easily permeable to small crystalloidal ions.

This fact leads, under proper conditions, to an unequal distribution of the diffusible crystalloidal ions between a protein solution and an outside aqueous solution; or between a protein gel and an aqueous solution. In this distribution the total concentration of crystalloidal ions is always greater inside the protein solution or inside a gel than in the surrounding aqueous solution. This is the cause of the colloidal behavior of protein solutions and protein gels. Measurements of membrane potentials have shown that this excess of the concentration of crystalloidal ions inside over the concentration of the crystalloidal ions outside the protein solution or the gel, and consequently all the effects of electrolytes on osmotic pressure, swelling and viscosity of proteins, can be calculated with a satisfactory degree of accuracy from Donnan's equilibrium equation, which is not an empirical but a rationalistic mathematical formula. We can therefore state that it is possible to explain the colloidal behavior of proteins quantitatively on the basis of a rationalistic mathematical formula. What appeared at first as a new chemistry, the so-called colloid chemistry, now seems to have been only an overlooked equilibrium condition of classical chemistry; at least as far as the proteins are concerned. The oversight was due to two facts, first, to the failure of colloid chemists to measure the hydrogen ion concentration of their solutions, which happens to be the chief variable in the case, and second, to their neglect of measuring and taking into consideration the membrane potentials of protein solutions and protein gels, which furnish the proof that the theory of membrane equilibria must be used to explain the colloidal behavior of proteins.

JACQUES LOEB

THE ROCKEFELLER INSTITUTE
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NEW YORK

## THE AWARD OF THE HENRY DRAPER MEDAL

THE Henry Draper medal for 1921, awarded by the National Academy of Sciences to Professor Henry Norris Russell, professor of astronomy at Princeton University, was presented to him by Dr. C. G. Abbot, assistant director of the Smithsonian Institution at the annual dinner in New York City on November 15. Dr. Abbot spoke as follows:

The brilliant and penetrating insight of Dr. Henry Norris Russell, of Princeton University, has led in recent years to a development of astronomy so rapid that it has proved thus far impossible to publish really up-to-date text-books on the subject. Before the manuscript of a text on astronomy can be prepared, much less carried through the press, new knowledge renders the treatment stale.

Dr. Russell has made basic contributions to the great problem of stellar evolution. He saw clearly that the brightness of a star as we see it depends on several factors. First, there is the intrinsic brightness of the star as a source of light. What the tallow candle is to the electric arc, so one star may be to another in the brightness of its shining surface. Secondly, the total amount of light which a star sends out depends upon its diameter. Quite recently it has been shown, for instance, that the star Alpha Orionis is three hundred times the diameter of the sun, and accordingly its cross-sectional area is ninety thousand times the cross-sectional area of the sun. Hence, if they were of equal surface brightness, the star Alpha Orionis would send out ninety thousand times as much light as the sun. In the third place, the brightness of the star depends upon its distance from the earth and falls off as the square of that distance. Thus, the sun, which is so near that it takes light eight minutes to come from it, being about two hundred thousand times as near as the next nearest star which takes light three or four years to reach the earth will appear forty million times brighter on that account.

With these conditions in mind, Dr. Russell, in collaboration with Dr. Hinks, of England, began by the application of a new photographic method of determining the distance of stars, and in 1910 published the results showing the approximate distance of 55 stars. With this and other such information which had been laboriously acquired by others, he was able to show that the red stars evidently must fall into two classes: one class sending out very much more light than our sun, and another sending out very much less, and that between these two very widely separated extremes there are no red stars intervening.

Going on, he applied the, until then little used, knowledge of the eclipsing variable stars with the

most penetrating theoretical ability. For many years measurements have been going on at Harvard Observatory and elsewhere on the march of brightness of such stars as Algol, in which we see a pair of objects which in their rotation about their common center of gravity periodically eclipse each other. Dr. Russell showed how the elements of the eclipse, comprising the observed brightness and the corresponding times, could be treated in order to give probable relative values of the densities of stars in the different eclipsing systems, and with his pupil and collaborator, Dr. Shapley, who applied Russell's methods, the results for 87 stars were obtained and published in 1913.

In the meanwhile, many additional stars had been measured for distance from the earth, and by combining the information then available, Russell showed in 1913 that the stars may be divided into two extraordinary sequences which, following Hertzsprung, he called the "giants and dwarfs."

In short, the "giants" beginning with the red and going on to the yellow, white and blue, form a series of substantially equal output of light far in excess of that which is expended by our sun, and their densities, beginning with the red stars which are so rare that the material of which they are composed is more to be compared to a fairly high vacuum than to ordinary gaseous, liquid or solid densities, increase as the sequence goes on until with the blue stars the density has become much more considerable.

From this point the descending series of the dwarfs begins, and the density reaches in our yellow sun about one and one half times that of water and from this goes on to the very red and small stars whose density is as great or greater than that of the earth itself.

So regular is the light progress of this fascinating series of dwarf stars that if one merely observes the type of spectrum which one of its members possesses he can tell with reasonable limits the total amount of light which is emitted and therefore, in connection with its apparent brightness, can determine the probable distance away from the earth in space.

On the other hand, if a cluster, such, for instance, as the great cluster in Hercules which are known to be stars of substantially equal distance from the earth, contains a group of stars of approximately equal brightness ranging through all the types of spectrum from the blue to the red, it follows that they are all giants and therefore emitting light of a roughly known quantity thousands of times in excess of that emitted by the sun, and from this the distance of the cluster can be fairly well estimated. Such considerations have been pursued by Dr. Shapley in regard to a great many of the clusters of stars, and have led him to assign distances in the stellar system some tenfold in excess of those which have been generally assumed before.

Professor Russell, taking as his text the frescoes on the walls of the banquet hall which, being known as the "College Room," was decorated exclusively with scenes of college sport, replied as follows:

Team work wins in science as well as in games. But there is this important difference, that scientific team work is free cooperation; there is no coaching and no central control.

If I have done anything to deserve this medal, it is because of the many men who have contributed to these investigations. I was particularly indebted to Professor Pickering of Harvard for the encouragement that he gave to a young and unknown instructor in his science. When I talked to him about my proposed work on stellar parallaxes, he volunteered his aid and provided me with observations of the magnitudes and spectra of 300 stars, which gave me the first evidence of the existence of giant and dwarf stars. Robert Ball says that "astronomy consists in sitting up all night and doing arithmetic all day." Some men like the one thing better than the other. My part has been largely doing arithmetic. But this would not have amounted to anything without the men who were willing to sit up all night. Here, again, is scientific team work.

At Princeton we are working on double stars. If you can guess how massive a star is, you can calculate how far away it is. If you can guess at the mass of a double star you can calculate its distance. Now double stars—at least, those with spectra of the same sort—are remarkably alike in mass, so that the guess that those which we have not yet investigated are similar to those which we know about is likely to be a very good guess. In this way we have nearly finished calculating the distances of about 1,600 double stars. To calibrate our formulæ, we use parallaxes determined in other ways, which have been generously sent us (published and unpublished material alike) by Drs. Adams and Schlesinger. All the investigators of stellar distances are now playing on the same team.

Not only must astronomers cooperate in research, but they must have the aid of the physicists and chemists. To know more about the stars we must know more about atoms. In fact, we would not know anything about the stars, even

their existence, if it were not for the atoms, which send us information by means of light. As we now know, each particular kind of light comes from one particular atom behaving in a particular way, each line in the spectrum is due to a special kind of atomic behavior.

As seen with the spectroscope, the white or hottest stars seem to be made of permanent gases, and the red and cooler stars to consist of metallic vapors. The difference in the character of the stars is probably not due so much to differences in constitution as to the character of the radiation given off by the atoms. If an electron is knocked off by an atom we get a new set of spectral lines. If another electron is knocked off, we may get an ultra violet spectrum, which can not be seen or even photographed, since the air is opaque to such short wave lengths. Such gases as oxygen, nitrogen and helium are hard to excite, so they do not show at low temperatures. But in the hot stars they get stirred up and become visible. In this case the metals are so knocked to pieces that they do not make themselves visible at all. All the stars may have similar composition, but, since the physical conditions are different, different elements reveal their presence in the spectra.

The relative degree of ionization of different elements (which determines the appearance of the spectra) depends on an equilibrium under the law of mass action.

I had always supposed that this law was the exclusive property of the chemist; but now it appears to be of fundamental importance in astro-physics. We need the chemist on our team, and we may help in their game too. By comparing the spectroscopic behavior of their lines in the sun, sun-spots and stars, it appears that the ionization potentials of all the elements in the periodic table between calcium and nickel are between 6 and 9 volts, increasing steadily along the series. So here astronomy gives information about properties of atoms, which have not as yet been measured in our laboratories, owing to practical difficulties. There is no limit in sight to the possibilities of team work such as this.

## APPEAL ON BEHALF OF THE LEAGUE OF NATIONS FOR AID TO AUSTRIAN INTELLECTUAL WORKERS

No greater danger can threaten a civilization than the successive destruction of its homes of learning. It is beyond dispute that the war and its economic consequences have brought intellectual life in one entire region of Europe into an extremely precarious position. The machinery of intellectual life has been seriously impaired in almost all those nations of eastern Europe, to say nothing of Russia, which extend from the Baltic to the Ægean. One of them—Austria—is suffering from economic distress to a degree which threatens soon to bring all intellectual work to a standstill in the winter of 1922-1923.

The truth of this statement is demonstrated by the report which we attach to this letter. Since the report was drawn up, the situation has been greatly aggravated, and its consequences are: (1) intellectual isolation; (2) a complete lack of all the appliances which are indispensable for intellectual work; (3) the formation of an intellectual proletariat, less favorably situated than the working-class proletariat—for muscle commands better wages than brain; (4) diminishing numbers of students and a dearth of recruits of the cultured classes for the liberal professions and for the teaching staffs.

The committee on intellectual cooperation, constituted by the League of Nations, decided, at its first meeting on August 1, 1922, "expressly to call the attention of the Council of the League of Nations to the desperate situation of intellectual life in certain European countries and the urgent need of intervention." These words had special reference to the case of Austria.

At its meeting of October 4, the Council of the League of Nations requested the committee to launch an urgent appeal to universities, academies and learned societies in all countries in aid of Austrian intellectual workers and intellectual life in Austria. We have accordingly the honor, in the present letter, to invite you to organize measures of relief as soon as possible, with the object of saving one of the most cultured countries in Europe—a country which formerly possessed one of the chief centers of European civilization—from the fate of seeing its higher education and learning disappear from sheer want.

We leave it to your judgment to organize

such relief measures as you may deem most practical and to employ such methods as you may consider most efficacious; we are prepared to supply you, through our secretariat, with any information or explanations which you may require. We merely beg to draw your attention to the following points:

As a result of the depreciation in the Austrian exchange, quite insignificant sums, if converted into crowns, amount to very considerable figures. For instance, we have pointed out in the attached report that, with the aid of 1,000 Swiss francs, the Academy of Science in Vienna could resume its publications, and that a sum of 500 Swiss francs would enable almost any of the great scientific associations—such as the Anthropological Society or the Society for Modern Philology—to recommence their work.

We earnestly invite the universities, academies and learned societies of the whole world to send their publications to the Austrian universities, academies and learned societies, or to organize systems of exchange with them. We urge them to conclude with the *Amba* (the Austrian "office for providing books and instruments") agreements for cooperation similar to that established with England. Such agreements would provide an excellent basis for the organization of intellectual relief and might be extended, with suitable adaptations, to other countries whose needs are similar to those of Austria.

As regards the supply of purely material requirements (such as clothing, boots, articles of primary necessity, etc.) it is suggested that agreements should be concluded with the *Zegam* (the "Central Purchase Organization for Associations of Intellectual Workers").

We further invite universities, academies and learned societies to organize the exchange of professors and lecturers with similar establishments in Austria, and we suggest that men of science should either visit Austria themselves or endeavor by means of personal intercourse to break down the wall of intellectual isolation with which that unfortunate country is surrounded.

In order to relieve the unhappy condition of Austrian professors, men of science, writers and artists, who are suffering increasingly from under-feeding, we would urge you to assist them and their families to spend their holidays abroad.

It might even be possible—and no form of assistance could be more useful or more urgently desirable—to place certain immediately available funds or foundations at the disposal of Austrian men of science and students in order to enable them to continue their researches and studies.

The aim of these suggestions, which are put forward at the beginning of a winter which may well prove decisive for the fate of Austria, is to encourage to the utmost the organization of relief measures from as wide a field and in as uniform a manner as possible.

Much can be accomplished with small means.

In coming to the assistance of Austria, and of other nations whose intellectual life is in danger, you will be strengthening that sense of professional brotherhood which should unite all brain-workers, you will be taking effective and practical action to promote intellectual cooperation, and, above all, you will be helping to support civilization in the struggle against the most serious peril which threatens it. For these reasons we are confident that our appeal will not be launched in vain.

For the committee on intellectual cooperation:

H. BERGSON,
of the "Académie Française,"
*President*

G. DE REYNOLD,
Professor of Berne University,
*Rapporteur*

O. DE HALECKI,
Professor of Warsaw University,
*Secretary*

GENEVA,
NOVEMBER 4, 1922

## SCIENTIFIC EVENTS

### LONDON BIRD SANCTUARIES[1]

THE committee on the establishment of bird sanctuaries in the royal parks, appointed by

[1] From the London *Times*.

Lord Crawford last year, has already added to the amenities of London. Early this spring small enclosures in Hyde Park and Kensington Gardens were prepared by suitable fencing, a small amount of planting, and exclusion of tidying gardeners. The birds accepted the hospitality; no fewer than twenty species, including willow wrens, great and blue tits, redbreasts and lesser whitethroats, spotted flycatchers, carrion crows, tawny owls, pheasants and moorhen nested there this year. According to a report just issued by the committee, it is proposed to extend these successful experiments. In Hyde Park the bank near the framehouse and an enclosure beside the magazine are to be allowed to grow wild, and some planting of suitable shrubs is to be carried out. The area on the east side of the Long Water in Kensington Gardens and a smaller enclosure on the west side are to be sanctuaries. The Duck Island in St. James's Park, two or three sites in Buckingham Palace Gardens, by consent of His Majesty, the islands in the lake in Regent's Park, the wilderness in Greenwich Park, and the Isabella Plantation in Richmond Park are all to be prepared and reserved. These admirable sanctuaries, due to the initiation of Mr. Harold Russell, a well-known London ornithologist, cost little, give pleasure to many, and will not incommode a single human being. They are not to incommode even the London cats, for the committee, after consultation with the Office of Works, decided that there was no practical cat-proof fence. But war is declared against the grey squirrels, absolute to extermination in Richmond Park, and intermittent in Hyde Park and Kensington Gardens. Public sentiment will be on the side of these pleasant rogues. The charge against them, of being habitual robbers of nests, is not proven, but, were it so, there are fences in the London Zoo which retained them, and which, therefore, could exclude them from the sanctuaries. Their charm persists through the year, and is, indeed, even greater in the bleak months when the migrant birds have left their sanctuaries bare. But perhaps they will succeed in defeating even Lord Crawford's competent committee.

## THE AMERICAN ELECTROCHEMICAL SOCIETY

THE forty-third semi-annual meeting of the American Electrochemical Society will be held in New York City, at the Hotel Commodore, on May 3, 4 and 5, 1923. The principal attractions of the technical program will be a whole day session on the general topic: "The Production and Application of the Rarer Metals." The arrangements for this session are in charge of Dr. F. M. Becket, of the Electrometallurgical Corporation, New York City. There will be papers on vanadium, tungsten, cobalt, molybdenum, zirconium, cerium, uranium, tantalum, calcium, magnesium and others.

Among the speakers will be:

H. N. McCoy, president of the Carnotite Reduction Company, of Chicago.

H. W. Gillett, of the Bureau of Mines, Ithaca, N. Y.

B. D. Saklatwalla, of the Vanadium Corporation.

F. E. Carter, of the Baker Platinum Works, Newark, N. J. (paper on platinum).

H S. Cooper (paper on zirconium metal).

J. A. Holladay, of the Eletrometallurgical Corporation (paper on analyses).

M. A. Hunter, of the Rensselaer Polytechnic Institute, Troy, N. Y. (two papers; one on Ti).

Mr. Clancy (paper on alloys as catalyzers)

Mr. Cutter, of the Climax Molybdenum Company.

Russel Lowe, Bario Metal Corporation (paper on bario metal).

Colin G. Fink, secretary of the society (paper on tungsten).

C. E. Minor, Aravaipo Leasing Company, Klondyke, Graham County, Arizona.

W. R. Whitney, director of research laboratories, General Electric Company, Schenectady, N. Y.

Another session will be devoted to a discussion of "Electrode potentials," headed by Dr. Wm. G. Horsch, of the Chile Exploration Company, New York. The papers will cover studies on:

(*a*) Reversible electromotive force.
(*b*) Overvoltage.
(*c*) Ion activities and dissociations.
(*d*) Electro-titration.
(*e*) $p_H$ determinations.

The headquarters of the society are at Columbia University, New York City.

## PROFESSOR MAX WEBER

THERE is printed in *Nature* the following letter addressed on December 5 to Professor Max Weber, of Amsterdam:

You celebrate your seventieth birthday to-day, and we, who are your colleagues and are but a few of your many friends in England, join together to congratulate you and to wish you many years to come of work and happiness. By your long life of teaching aand research, by your leadership of the *Siboga* Expedition, by your great handbook of the Mammalia, and by innumerable other important publications, you have come to be the acknowledged leader of zoology in the Netherlands and to be recognized far and wide as one of the most distinguished naturalists of our time. Your solid learning has upheld the great scientific traditions of your country, your investigations have influenced and stimulated many of us, your broad interests, your singleness of purpose, the simplicity of your life, and your genius for friendship have set an example to us all.

The letter is signed by the following leading British naturalists:

A. Alcock, E. J. Allen, Chas. W. Andrews, J. H. Ashworth, W. Bateson, Gilbert C. Bourne, W. T. Calman, Geo. H. Carpenter, Wm. J. Dakin, Arthur Dendy, J. C. Ewart, F. W. Gamble, J. Stanley Gardiner, Walter Garstang, James F. Gemmill, Sidney F. Harmer, J. R. Henderson, W. A. Herdman, Sidney J. Hickson, Jas. P. Hill, Wm. Evans Hoyle, J. Graham Kerr, E. W. MacBride, W. C. McIntosh, Doris L. Mackinnon, P. Chalmers Mitchell, C. Lloyd Morgan, Edward B. Poulton, R. C. Punnett, C. Tate Regan, G. Elliot Smith, Oldfield Thomas, D'Arcy W. Thompson, D. M. S. Watson, A. Smith Woodward.

## OFFICERS OF THE AMERICAN CHEMICAL SOCIETY

DR. EDWARD C. FRANKLIN, professor of organic chemistry of Leland Stanford Junior University, has been elected, as already announced, president of the American Chemical Society, succeeding Dr. Edgar F. Smith, formerly provost of the University of Pennsylvania.

Dr. Wilder D. Bancroft, of Cornell University, was reelected a director of the society and William Hoskns, consulting chemist, of Chicago, was made a new director of the society. The following councilors-at-large for the period from 1923 to 1925 also were elected: Drs. Roger Adams, University of Illinois; G. N. Lewis, University of California; Ralph H. McKee, Columbia University, and William McPherson, the Ohio State University.

Dr. Franklin was born at Geary City, Kansas, in 1862. He was graduated from the University of Kansas in 1888 and received his master's degree in 1890. He was a student at the University of Berlin in 1890-91; he received the degree of doctor of philosophy at Johns Hopkins University in 1894. He was a member of the advisory board of the U. S. Bureau of Mines in 1917-18; physical chemist of the U. S. Bureau of Standards and consulting chemist of the Ordnance Bureau of the Army during the war. Dr. Franklin's work on liquid ammonia as an electrolitic solvent is familiar to all chemists. In addition to his university work, he also was in industrial work for a number of years, serving in the sugar industry and also in the gold mining industry. In the latter work he was stationed at Miramar, Costa Rica, in 1897.

Dr. Franklin was chosen from among the four nominees for president of the society who received the largest number of votes from members of the society. The choice among these four was determined by a vote of the councilors. The three other leading candidates were Dr. James F. Norris, of Massachusetts Institute of Technology, Professor Samuel S. Parr, of the University of Illinois, and Dr. Charles L. Reece, chemical director of E. I. du Pont de Nemours and Company, of Wilmington, Delaware.

## THE HAYDEN AWARD OF THE PHILADELPHIA ACADEMY

THE Academy of Natural Sciences of Phildelphia announces the selection of Professor Alfred Lacroix, president of the Geological Society of France, as the recipient of the "Hayden Memorial Geological Award" for 1923. This award was created by a deed of trust made with the academy, on April 11, 1888, by Mrs. Emma W. Hayden, widow of Dr.

Ferdinand V. Hayden, one time director of the United States Geological Survey, "as a reward for the best publication, exploration, discovery or research in the sciences of geology and paleontology." The award consists of a gold medal, and is made every three years. Previous to 1900 the award consisted of a bronze medal and was made annually.

Professor Lacroix was born February 4, 1863, at Mâcon, province of Saône-et-Loire, France. Educated at the Lycée of Mâcon, at the Sorbonne and at the Collège of France, he received the degree of doctor of science in 1889. In 1893 he was made professeur at the Muséum d'Histoire Naturelle, and in 1896, director of the Laboratoire de Minéralogie, École des Hautes Études. In 1904 he was elected a member of the Académie des Sciences, and ten years later he became Secrétaire perpetual of the Section of Physics of the Académie. Professor Lacroix's numerous and important publications and discoveries, as well as his exhaustive studies of Mont Pelée, of the phenomena of contact metamorphism and endomorphic metamorphism are familiar to all geologists.

The committee by whom the nominee for the 1923 award was selected consisted of Dr. Richard A. F. Penrose, Jr., *chairman,* Dr. John M. Clarke, Dr. Henry Fairfield Osborn, Dr. Charles D. Walcott and Dr. Edgar T. Wherry.

Previous recipients of the Hayden award were: 1890, James Hall; 1891, Edward D. Cope; 1892, Eduard Suess; 1893, Thomas H. Huxley; 1894, Gabriel August Daubrée; 1895, Karl A. von Zittel; 1896, Giovanni Capellini; 1897, A. Karpinski; 1898, Otto Torrell; 1899, Gilles Joseph Gustave Dewalque; 1902, Archibald Geikie; 1905, Charles D. Walcott; 1908, John Mason Clarke; 1911, John C. Branner; 1904, Henry Fairfield Osborn; 1917, William M. Davis; 1920, Thomas Chrowder Chamberlin.

## SCIENTIFIC NOTES AND NEWS

A PORTRAIT of Sir Joseph Thomson, by Mr. Fiddes Watt, has been presented by a number of subscribers to the Royal Society.

DR. FRIDTJOF NANSEN, who recenty received the Nobel peace prize, received a further award when it was announced by the Nobel Committee that Christian Erichsen, of Copenhagen, had granted another award to Dr. Nansen equal in value to the Nobel peace prize, in recognition of his work on behalf of the starving millions of Europe. Dr. Nansen proposes to use the prizes for relief work.

DR. IRVING LANGMUIR, research chemist of the General Electric Company, has been elected an honorary member of the Royal Institution, London.

EDWARD LONGSTRETH MEDALS were presented by the Franklin Institute, Philadelphia, on December 20 to Dr. A. H. Pfund, of Baltimore, for his cryptometer, paint film gauge, colorimeter and rotating sector, and to Mr. Edward J. Brandt, of Watertown, Wis., for his automatic cashier.

WE learn from the *Bulletin* of the American Mathematical Society that on the occasion of the celebration of its seven hundredth anniversary the University of Padua conferred its honorary doctorate on Professors R. C. Archibald, of Brown University, J. Lipka, of the Massachusetts Institute of Technology, and V. Snyder, of Cornell University.

THE University of Frankfort and the Zurich Technical School have conferred honorary degrees on Dr. David Hilbert, professor of mathematics at Göttingen, on the occasion of his sixtieth birthday.

DR. E. H. STARLING, professor of physiology in the University of London, has been appointed the first Foulerton professor under the foundation of the Royal Society created by the will of the late Miss L. A. Foulerton.

SIR GEORGE GREENHILL has been awarded a pension by the British government in recognition of his services to science and his ballistic work.

ON December 8 the members of the department of botany of the Ohio State University and friends celebrated with a dinner the completion of twenty-five years of service of Professor John H. Schaffner in the department.

DR. FRANCIS CARTER WOOD, director of the Institute of Cancer Research, Columbia Uni-

versity, received an "honorary degree" from the Radiological Society of North America, on December 7, 1922, in recognition of his experimental researches on X-ray and cancer.

FRANKLIN THOMAS, professor of civil engineering at the California Institute of Technology, was recently elected a member and vice-chairman of the Board of Directors of the City of Pasadena, Calif. He is first vice-president of the Pasadena Chamber of Commerce.

PROFESSOR EDSON S. BASTIN, chairman of the department of geology in the University of Chicago, has been appointed a member of the State Board of Natural Resources and Conservation by the governor of Illinois. Professor John Merle Couler, head of the department of botany, is already a member of the board.

PROFESSOR JOSEPH EUGENE ROWE, head of the department of mathematics in the College of William and Mary, was the official delegate from the State of Virginia at the annual meeting of the American Society of Mechanical Engineers held in New York City during the week of December 4.

AT the annual general meeting of the Faraday Society, London, held on November 20, Sir Robert Robertson was elected president. The vice-presidents are: Professor C. H. Desch, Professor F. G. Donnan, Dr. J. A. Harker, Professor T. M. Lowry, W. Murray Morrison, Professor J. R. Partington and Dr. G. Senter.

JOHN OLIVER LA GORCE, associate editor of the *National Geographic Magazine* and trustee of the National Geographic Society was elected a vice-president of the society on December 13.

AT a general meeting of the members of the Royal Institution held on December 4, Sir Arthur Keith was elected secretary in succession to the late Colonel E. H. Grove-Hills.

DR. I. P. TOLMACHOFF, formerly chief keeper of the Geological Museum at Petrograd, has been appointed curator of invertebrate paleontology in the Carnegie Museum at Pittsburgh, Pa. Dr. Tolmachoff, who has been in Vladivostok for some time, has arrived in Pittsburgh and assumed his new duties.

JULIUS MATZ, pathologist of the Insular Station of Porto Rico, has been engaged to conduct research in agriculture for Central Porvenior, San Pedro de Macoris, Dominican Republic.

PROFESSOR L. KAHLENBERG, of the chemistry department of the University of Wisconsin, lectured at the University of Illinois on December 7 on "The chemical replacement of the metals by one another."

THE Academy of Sciences and the Philosophical Society of Washington held a joint meeting on December 21, when Dr. H. A. Clark, physicist of the Taylor Instrument Companies, Rochester, N. Y., delivered an address on "The manufacture of thermometers."

DR. LUDWIK SILBERSTEIN, mathematical physicist, Eastman Kodak Company, Research Laboratory, gave the following lectures at Harvard University on December 18, 19 and 20: "Oriented quantum emission and the selective principle of spectroscopy"; "Perplexities in the domain of non-hydrogenic spectra"; "Rotational terrestrial optical experiment and its bearing upon fundamental physical questions."

DR. WILLIAM T. BOVIE, assistant professor of biophysics at Harvard University, will deliver the fourth Harvey Society lecture at the New York Academy of Medicine, on January 13. His subject will be "The physiological effects of light rays."

PROFESSOR R. G. HOSKINS, head of the department of physiology of Ohio State University, will deliver the annual address before the Portland, Oregon, Academy of Medicine on January 11 and 12.

SPENCER BAIRD NEWBERRY died on November 28 at the age of sixty-five years. Dr. Newberry, a son of John Strong Newberry, was at one time professor of chemistry at Cornell University and in 1893 founded the Sandusky Cement Company. He made important contributions to the scientific study of cement.

HENRY JOHN ELWES, distinguished for his contributions to forestry and other sciences, died on November 26, at the age of seventy-six

years. Mr. Elwes was a fellow of the Royal Society and had been president of the Royal Entomological Society of London and of the Royal English Arboricultural Society.

JOHN HENRY GURNEY, the English naturalist and ornithologist, died at his residence, Keswick Hall, near Norwich, on November 9, aged seventy-five years.

THE first of the customary lectures arranged by the Central Ohio Chapter, at the Ohio State University, of the Society of Sigma Xi, following its usual program for the encouragement of research, was a lecture with experimental demonstrations by Mr. Thomas Midgely, Jr., and Mr. T. A. Boyd, research fuel engineers of the General Motors Research Corporation of Dayton, entitled, "The chemical control by catalysis of detonation." Experimental demonstrations of the use of selenium and lead derivatives were made with internal combustion engines. The program is under the direction of the new officers of the local chapter, namely, James R. Withrow, professor industrial chemistry, president; Edward Mack, Jr., assistant professor of physical chemistry, secretary, and C. A. Norman, professor of machine design, retiring secretary.

THE directors of the Fenger Memorial Fund have set aside $500 for medical investigation. The work should have a clinical bearing and if possible it should be carried out in an institution that will furnish facilities and ordinary supplies free of cost. Applications with full particulars should be sent to Dr. L. Hektoen, 637 S. Wood Street, Chicago, before January 15, 1923.

MR. ARTHUR H. HELME, whose gift to the Museum of the Brooklyn Institute of Arts and Sciences of a large collection of Long Island birds and mammals was announced during the spring, has been engaged since summer in affixing labels bearing name, locality and date to all of his specimens, which, instead of the original estimate of 3,000, it has now been shown number about 4,000. This donation, together with that of Mr. Peavey, Mr. Puttfarcken and others, represents the addition of fully 5,000 specimens, all received during the present year and this signifies that the Brooklyn Museum has attained its goal in now possessing the most exclusive and authentic collection of birds and mammals from Long Island.

THE Hurley expedition, which left Australia in August with a flying boat and seaplane to explore the country at the head of the Fly River, Papua, has had its plans dislocated by climatic conditions. The air pilot, who has reached Brisbane, reported that the machines were found unsuitable. Rain every night and terrific heat by day destroyed the fabric covering and made it unsafe to proceed. The only planes possible in such country must be of metal, with high horse-power.

THE first number of a new Italian mathematical journal, entitled *Bolletino della Unione Matematica Italiana*, was issued under the date of October, 1922. S. Pincherle, of Bologna, is provisional president of the union.

IT is announced by the United States Geological Survey, that the price of radium has decreased owing to the discovery of radium bearing ores in Africa, which are easily worked at a much lower cost than the American mines. This caused a drop from $120,000 a gram to $70,000, which is the lowest price at any time since radium has been used. In connection with Cancer Week, the Survey announced, the state of New York and the city of Philadelphia have each bought two grams for the use of their citizens, and the city of Quebec one gram.

THE Seismos-Gesellschaft, of Hanover, Germany, has lately issued a pamphlet on the determination of underground geological structures and ore deposits by seismic methods, apparently an outcome of devices used in locating heavy guns in the war. The needed apparatus can be carried by two men. The work is said to be more expeditious and economical than exploration by borings. A number of sectional illustrations of investigated structures are included.

THE Swedish Parliament, as reported in *Eugenical News*, voted, May 13, 1921, to establish a Swedish Institute for Race-Biology with 82,500 crowns (Swedish) in addition to the salary of the director. Of this sum, 24,000 crowns are to be utilized for the first equip-

ment of the institute, 26,500 for working expenses, and the remainder for salaries for assistants during 1922. Work began January 1, 1922. The institute has its own council, appointed by the king and standing directly under the government. At present it is located at Upsala and the director is nominally on the university staff; but the institute is governmental rather than university department or agency. The first council comprises: H. Hammarskjöld, lord lieutenant of Upland; A. af Jocknick, Esq., director general in the Royal Committee for Pensions, Stockholm; F. Lennmahn, M.D., rector of the "Karolinska Institutet," Stockholm; Mrs. Emilia Broomé, Stockholm; J. V. Hultkranz, M.D., professor of anatomy, Upsala University; H. Nilsson-Ehle, M.D. and Ph.D., professor of heredity in Lund University (at Åkarp); H. Lundborg, M.D., director of the institute. The present staff includes: Dr. F. J. Linders, statistician, archivist and vice director; G. Dahlberg, M.D., medical assistant, at present doing anthropometric work; Dr. W. W. Krauss (formerly of Vienna), assistant anthropologist; E. Heckscher, genealogist; Mrs. G. Dahlberg, who helps her husband in anthropometric work, recorded as social worker; and Mr. E. A. Ohlsén, photographer.

## UNIVERSITY AND EDUCATIONAL NOTES

GROUND has been broken for the new laboratory of the department of hygiene and bacteriology at the University of Chicago to stand between the psychological laboratory on the north and the university press on the south. The building, of brick, will front 110 feet on Ellis Avenue and will contain a general laboratory, a laboratory devoted to the bacteriology and chemistry of water and foods, five research rooms, a room equipped with sterilizing devices, and an animal room.

BY the will of the late General Frank Sherwin Streeter, Dartmouth College receives $50,000. A bequest of $10,000 is left to Dr. Ernest M. Hopkins, president of the college.

THE council of the senate of the University of Cambridge has issued a report on the allocation of the Special Government Grant, which has now become a recurrent grant of £30,000. This is divided as follows: Professorships, £14,675; readerships, £5,304; university lectureships, £3,750; university officers, £3,240; grant to Geographical Education Fund, £250; university library, £2,000; Museum of Classical Archeology, £750.

AT Indiana University, Associate Professor U. S. Hanna has been promoted to a full professorship, and Assistant Professor Cora B. Hennel to an associate professorship of mathematics.

THE *Bulletin* of the American Mathematical Society states that, on the return of pre-war conditions, the U. S. Naval Academy has reduced the number of its civilian officers of instruction in academic departments by about one third. From the department of mathematics, Assistant Processors R. P. Johnson and G. F. Alrich have accepted assistant professorships at the Carnegie Institute of Technology, and Mr. L. S. Johnston an assistant professorship at Pennsylvania State College.

DR. RAYMOND A. DART, formerly of Sydney University, Australia, and recently of the anatomical department, University of London, has accepted the professorship of anatomy in the University of Witwatersrand, Johannesburg, South Africa, where a new medical college building has recently been completed. Dr. Dart came to the United States two years ago on the invitation of the Rockefeller Foundation to examine American laboratories and methods of teaching, and to help encourage the development of a better understanding and closer relations between English and American scientists teaching in medical schools. As traveling fellow of the foundation, Dr. Dart spent some time in our laboratories, and at the Marine Biological Laboratory at Woods Hole, Mass., where he was married to Miss Dora Tyree, assistant in anatomy at the University of Cincinnati.

DR. HOLBURT J. WARING has been elected dean of the faculty of medicine of the University of London.

# DISCUSSION AND CORRESPONDENCE

## RESEARCH IN MARINE BIOLOGY

TO THE EDITOR OF SCIENCE: Notices of the death of Dr. Alfred Goldsborough Mayor have referred to the lamentable possibility that the undertaking in marine biology which he directed might fail to be continued. Mr. Potts,[1] Professor Coe,[2] Dr. Davenport[3] and Dr. Schaeffer,[4] among others, have voiced or hinted at this fear, that a chief American instrument for research might be abandoned. Emphasis has been placed upon the unique opportunities until now provided by the Carnegie Institution Department of Marine Biology for investigations involving travel to more or less distant places, where material of unusually favorable type might (for a short time) be available to especially qualified students.

There is another side to this matter, and since there seems some likelihood of its being overlooked, I venture to comment upon it—for it is an aspect of marine research concerning which a continuous experience of several years as resident naturalist at the Bermuda Biological Station has given me strong convictions.

The "easy work" of zoology is to a large extent already done—although I have had expressed to me, by an eminent naturalist of the elder generation, the thought that "all the hard problems of zoology have been solved—you younger men need only to fill in the vacant spots." (Those "vacant spots"!) Research is costly. Adequate return for money and energy to be invested in biological investigation demands, and henceforth will increasingly necessitate, that the conditions attending investigative pursuits be the least unfavorable possible. Those whose varied experiences have provided an adequate background for judgment in this matter are unanimous in the conviction that the most suitable locations are to be found on the shores of tropical or semi-tropical seas. Supreme variety and abundance of animals, ease of access to them throughout the year, a comparative isolation conducive to their scholarly and productive treatment—these can be found in combination only in the warmer seas. There, some of the wasteful, merely mechanical, handicaps to fruitful research are eliminated.

It is not too much to take for granted, that studies of this nature are worth while. The financial support of numerous marine stations in America is sufficiently demonstrative. Yet if we examine the actual operation of these existing laboratories, we find that in general they are utilized for productive work during but a small portion of the year. The splendid material possessions of the Woods Hole Laboratory, to take an especially noteworthy instance, are as good as wasted, so far as research is concerned, during some eight to nine months of the year. The plain fact of the matter is that the existing American institutions for research in marine biology are either more or less unfortunately situated, with regard to climatic conditions or otherwise; or else overburdened in their potentially productive seasons by the requirements of elementary instruction—necessary work, and I speak of it only with respect; but it is not enough.

In Mayor's hands the Department of Marine Biology of the Carnegie Institution had before it two large tasks—the conduct of explorative expeditions, and the upkeep of a fixed laboratory serving as a central resort at favorable seasons. The workers at the Tortugas Laboratory being recruited from college and university staffs, and the possible season at Dry Tortugas brief at best, the actual time of the laboratory's session each year was necessarily short. The problems attackable under such conditions are limited in kinds. Some truly fundamental questions can not be faced at all without intimate knowledge of faunal conditions over extended periods of time. The notion, moreover, that "favorable material" for one kind of "problem" is to be found here in this place, for another kind there in that other place, is largely fallacious. Most naturalists acquainted with the subtropical marine fauna

[1] *Nature*, 110, 224.
[2] *Amer. Jour. Sci.*, Ser V, 4, 173.
[3] SCIENCE, N. S., 56, 134.
[4] SCIENCE, N. S., 56, 468.

have come into contact with it during only one part of the year, and are unaware of its seasonal fluctuations.

A permanent marine laboratory, adequately located, engaged actively in research during the whole year, I should suppose to be a cardinal necessity for biological development. As Mayor himself realized, the need is so obvious as to require frequent restatement; his reports, and letters from him, show that the realization of such a laboratory was for him a great hope.

In such a laboratory inquiries become possible which in other situations can hardly be undertaken at all. Temporary social isolation would perhaps have to be faced by resident investigators, and partial loss of contact with libraries; but there are compensations. Time to "sit still and think things over," on the ground, is of tremendous value in itself. The zoologist's business, I take it, is to provide an account of animals, in terms, ultimately, of the properties of materials and of their relations. An enormous segment of this task remains relatively unexplored. A truly scientific natural history of animals, prerequisite for the stability of biological theory, is still for the future. There is here a possibility of huge reward. To grasp it requires intensive work of a character which existing agencies for zoological inquiry do not make possible, for the work can not be done by means of visits to the seashore in summertime. A permanent laboratory in semitropical waters, moderately equipped, with a stationary staff, not cursed with a "program," could justify itself in this necessary work, and that without great expense.

That the only American institution for research in a position to fill this need may fail to do so, seems to me the most serious aspect of the case, rather than the possibility that another summer laboratory may be closed.

W. J. CROZIER

ZOOLOGICAL LABORATORY,
RUTGERS COLLEGE

## ON TRANSLATING EINSTEIN

TO THE EDITOR OF SCIENCE: Generally I am well pleased with whatever Dr. W. J. Humphreys writes but I can't say I like so much his pleasantly written criticism in *Science* of November 24. He says that he very much dislikes my little article on relativity in *The Scientific Monthly* of November, 1922.

Because, giving the words used the only meanings recognized by layman and scientists alike, save a few specialists, several of the assertions are sheer nonsense. Certainly no system of equations, however clever, can prove to one of common sense, the existence of a real fourth dimension; that time and space are not wholly independent; that just because we and the Martians may be unable to synchronize our clocks there is no "now"; that time is "curved"; that a phenomenon may be seen before it happens; that the mere inclusion of gravitation in a more comprehensive expression eliminates it from nature; and so forth, and so on, through a long list of absurdities—absurd, that is, if their customary meanings be given to the words used.

It is my custom, whenever I get a new scientific book to pick out the most perplexing passage and try to put it into ordinary language. It is more fun, to my mind, than trying to solve the problem of three bodies on a billiard table and pays better. The book I had in hand was the English version of "Time—Space—Matter" by Weyl, the leading exponent of *Einsteinismus* in Germany. The paragraph I selected for translation into the vernacular was the following: (p. 274.)

Every world-point is the origin of the double-cone of the active future and the passive past. Whereas in the special theory of relativity these two portions are separated by an intervening region, it is certainly possible in the present case for the cone of the active future to overlap with that of the passive past; so that, in principle, it is possible to experience events now that will in part be an effect of my future resolves and actions. Moreover, it is not impossible for a world-line (in particular, that of my body), although it has a time-like direction at every point, to return to the neighborhood of a point which it has already once passed through. The result would be a spectral image of the world more fearful than anything the weird fantasy of E. T. A. Hoffman has ever conjured up. In actual fact the very considerable fluctuations of the $g_{ik}$'s that would be necessary to produce this effect do not occur in the region of world in which we live. Nevertheless there is a certain amount of interest in

speculating on these possibilities inasmuch as they shed light on the philosophical problem of cosmic and phenomenal time. Although paradoxes of this kind appear, nowhere do we find any real contradiction to the facts directly presented to us in experience.

Now I have two favors to ask:

First, that any reader who is interested compare my little skit on "Tangling Up the Time Line" with this and see whether I have made any serious misuse of the text.

Second, that Dr. Humphreys put this same idea into five hundred words so that mathematicians would approve of it and editors accept it. I am proposing this, not because I think that Dr. Humphreys can't do it, but because I know he can. I greatly admire, and have often benefited by, his power of clear exposition and I want him to apply it in this case. I will not only thank him for it but I will pay him for it.

Somebody must do this job of translating Einstein and it ought to be done by thorough mathematicians like Dr. Humphreys rather than by outsiders like myself. I realize that translating mathematics is like translating music. Still I suppose that even the most complicated equation could be put into ordinary language though it would be so wordy and involved that nobody would read it. All that can be done is to give by illustrations and analogies some notion of the conception. I may say that, according to my custom, I submitted my version to a professor of mathematics in one of our leading universities, who specializes in Einstein and I reworked the wording twice in accordance with his suggestions although I will not incriminate him by mentioning his name.

Most of the "long list of absurdities" that Dr. Humphreys mentions are not in the article he criticizes; for instance, gravitation. I know that Einstein has not eliminated gravitation from the universe, for if he had I should have felt a sense of relief amounting to 187 pounds. What he has done is well expressed by Lord Haldane, in his "Reign of Relativity," when he says that Einstein's doctrine "has banished out of physics the necessity of attributing an objective character to gravitation," and he adds "a time may arrive when even the good old name gravitation will not be discoverable in any respectable textbook." The way Weyl puts it is: (p. 226).

> We shall find actually that the planets pursue the courses mapped out for them by the guiding field, and that we need not have recourse to a special "force of gravitation," as did Newton, to account for the influence which diverts the planets from their paths as prescribed by Galilei's Principle (or Newton's first law of motion).

Is not Weyl to be taken literally when he makes such a statement as the following: (p. 278)?

> We conclude that space is closed and hence finite. If this were not the case, it would scarcely be possible to imagine how a state of statistical equilibrium could come about. If the world is closed, spatially, it becomes possible for an observer to see several pictures of one and the same star. These depict the star at epochs separated by enormous intervals of time (during which light travels once entirely round the world).

Professor Eddington of Cambridge, who started the Einstein boom by his report of the British eclipse expeditions of 1919, puts this point still more plainly and literally in "Space, Time and Gravitation": (p. 161)

> Perhaps one or more of the many spiral nebulæ are really phantoms of our own stellar system. Or it may be that only a proportion of the stars are substantial bodies; the remainder are optical ghosts revisiting their old haunts. It is, however, unlikely that the light rays after their long journey would converge with the accuracy which this theory would require.

Both Weyl and Eddington are careful to state that what is theoretically possible may be a practical impossibility and I imitated their caution when I said:

> Such a thing (as the influence of the future on the present) is conceivable in the generalized theory of relativity, though, like most conceivable things, it does not occur, or is never known to occur, in reality.

I submit that this is a fair warning to the reader as to the speculative nature of these deductions and a fair translation of Weyl's words:

> In actual fact the very considerable fluctuations

of the $g_{1k}$'s that would be necessary to produce his effect do not occur in the region of the world in which we live.

I did not invent Einstein. I am not responsible for the theory of relativity or the deductions made from it by physicists and mathematicians. It seems to me that Dr. Humphreys' criticism should be directed toward them rather than toward their humble interpreter.

EDWIN E. SLOSSON
SCIENCE SERVICE, WASHINGTON

## ON THE FORMATION OF FAMILY NAMES LIKE TINGIDÆ

IT is astonishing to observe how great a display of erudition may be made in vain, the net result being error. In recent numbers of SCIENCE Dr. Holland, Mr. A. C. Baker and I have issued manifestoes on how to construct family names based on third declension *i*-stems not increasing in the genitive, and in each case the argument has been vitiated by at least one mistake. However, each author has contributed an item of truth, and it is now possible to settle the matter for good and all.

As Dr. Holland says, the stem of the Latin word *Tinge* is undoubtedly *Tingit-;* but, as Mr. Baker points out, Fabricius did not adopt this word, rather he introduced into the neo-Latin language the word *Tingis,* genitive *Tingis,* stem *Tingi-*. This brings us to my contribution, *i. e.,* that Fabricius considered *Tingis* "his own and indicated what its declension should be"—perhaps a somewhat misleading statement of the idea clearly formulated by Mr. Baker. My argument, however, had the merit of reaching the right conclusion, namely, that *Tingidæ* is the correct form for this family name, and I have no hesitation in diagnosing as pathological the form *Tingitidæ* in this particular case and *Tingiidæ* or its like in all similar cases.

I have always had a vague notion, founded chiefly on unconscious observation, that in forming patronymics from *i*-stems (not increasing in the genitive) the final *i* of the stem is to be dropped; and, indeed, who ever heard of such terms as Apiidæ, Aphiidæ, Feliidæ or Caniidæ, until the publication of the last number of the Proceedings of the Entomological Society of Washington?[1] To confirm or disprove this belief and so to settle the matter beyond question, I lately addressed an appropriate question to Mr. Henry Pennypacker, now of Harvard University and formerly Greek teacher and headmaster of the Boston Latin School. In reply I received the following statement of the grammatical principle concerned, as the joint opinion of my old teacher and of Professor Clifford H. Moore, head of the department of the classics at Harvard:

> Rules regarding the formation of family names which may be described as patronymics are subject to modification not only in the interest of convenience but also of euphony, and in spite of the fact that the stems of the nouns you mention [Nabis, Apis, Tingis, Coris, Aphis] in Latin end in "i" and that the termination "idæ" is conventional in such cases there seems to be no doubt that the spelling with a single "i" carries universal authority and the penultimate "i" is short in quantity.

The authors of the International Code, of course, were fully conversant with this principle and expected it to be applied in connection with Article 4, as it had been in the past.

Lest my acquaintance with the unexpressed expectations of the members of the commission be questioned, I should say that it is founded on three considerations: (1) They were and are educated men; (2) their own works contain no such monstrosities as "Feliidæ" or "Anguiidæ"; (3) authors and editors of standing throughout the world have unanimously acted upon the assumption which I have expressed above.

There remains the widely but not universally accepted belief that priority should obtain in family names, but the Code is not clear on this point (*i. e.,* What determines the type genus of a family?); however this may be settled in future, we arrive in the present instance at the following conclusions: (1) that *Tingidæ* is nomenclaturally and philologically correct, as Westwood was well aware when he proposed the name in 1840; and (2) that it will not be necessary to make the change in hundreds of

[1] The editor, Mr. A. C. Baker, substitutes the term "Aphiidæ" for the term "Aphididæ" used by the author of an article.

family, subfamily, tribal and divisional names which Mr. Baker's novel idea implies.

H. M. PARSHLEY

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## THE BEGINNINGS OF AMERICAN GEOLOGY

TO THE EDITOR OF SCIENCE: Referring to Dr. T. C. Mendenhall's article on page 661 of the current volume of SCIENCE, I desire to say that I have no wish to enter into any controversy in regard to the facts of Newberry's connection with the Geological Survey of Ohio and I sincerely hope for the benefit of the history of American geology that Dr. Mendenhall is correct. Moreover, I yield to none in my high regard for both Newberry and Orton. My reference was entirely to a period prior to Orton's accession to the directorship of the survey and to the feelings which Newberry publicly expressed at the time I was a student under him at the Columbia School of Mines.

In confirmation of which I can only add that Charles A. White, than whom none knew Newberry better, writes in his memoir that was published by the National Academy of Sciences as follows: 'In 1874 the work of the survey was suspended by failure of the legislature to provide the necessary funds and much dissatisfaction and even bitterness of feeling was engendered among those who had taken part or had been interested in it. Dr. Newberry thought and with apparently good reason that injustice had been done him in his relation to the survey."

MARCUS BENJAMIN

# QUOTATIONS

## THE FEDERAL BUDGET

THE estimates of the money needed by the federal government for 1924 are about $3,000,000,000, excluding the Post Office, which it is hoped will be self-supporting. At a very moderate estimate, over two thirds of this will be spent on wars past, present or future. Nearly half a billion goes to the veterans, about a billion goes into the service of the debt accumulated in the last war, well over half a billion to maintaining the army and navy.

Half of the total expenditure is a debt to veterans and to bondholders. It is fixed. The other half of the expenditure is for the army, the navy and the civil government. Here alone retrenchment is possible. Assuming that the administration sees no way to reduce the cost of the army and navy, but on the contrary, according to Secretaries Denby and Weeks, would like to increase these costs if possible, the taxpayer's position comes to this: If the whole civil government were dismantled or run free of charge the tax-saving would be less than 30 cents on a dollar.

Some part of this 30 cents is all that Mr. Harding has any hope of saving. The part which he is now thinking about is the part which goes into "research, improvement and development." Less than $11,000,000 goes to research. If it were all abolished it would save just a trifle over one third of a cent on each dollar. Ten millions goes to education. Abolish this item and you have cut your budget .003 per cent. Sixteen millions goes for public health. Cease this activity and you save half a cent on a dollar. Abolish all public works, river and harbor improvements, road construction, the Reclamation Service, Alaskan railroad expenditures, hospital construction and other public improvements and the total saving would be less than 5 cents on a dollar. Abolish everything in the way of "research, improvement and development" and the taxpayer would not save 7 cents on a dollar.

The budget figures are the greatest indictment of modern civilization. They show that two thirds of the energy of government goes to the business of fighting, and that less than a third of the remaining third goes to the civilized business of research, improvement and development.—*The New York World.*

## THE APPRECIATION OF SCIENCE

AT the anniversary dinner of the Royal Society it is customary to include among the guests some public men of distinction in other fields than those with which scientific men are concerned. Among such guests this year, at the dinner held on November 30, were Mr. Justice Darling, who proposed the toast of "The Royal Society," and Mr. L. S. Amery, first lord of the Admiralty, who responded to the toast of "The guests." If the assembly had consisted of leading representatives of literature or

art, music or the drama, neither of these speakers would have professed, facetiously or otherwise, want of knowledge of the functions of the institution they honored by their presence, or of the meaning of subjects surveyeed by it. Mr. Justice Darling, for example, said he had heard of the Royal Society as he had heard of the equator, and had been told that the society "concerned itself with medicine and biology, and particularly natural knowledge and natural philosophy, but the moment the knowledge became unnatural—and so far as he could see most of it was—then the society had nothing more to do with it." Of course, the society was founded for the promotion of *natural* knowledge by inquiry as against *supernatural* by revelation or authority. Mr. Justice Darling should understand the distinction, for he referred to Francis Bacon several times in the course of his remarks, though always incorrectly, as "Lord" Bacon. As Sir Charles Sherrington, who presided, said, "The field of truth which the society explores is in the realm of natural knowledge, and the manner of the exploration of this field is in research." Sir Ernest Rutherford was right when, in responding to the toast of "The Medallists," he referred to the spirit of adventure possessed by every scientific pioneer. In no other department of intellectual activity is this spirit more manifest, and in none are such fertile provinces being opened. To us it seems strange, therefore, that so little is commonly understood of the origin and purpose of such a body as the Royal Society, now in its two hundred and sixtieth year, or of the achievements of modern science represented by it.—*Nature.*

## SCIENTIFIC BOOKS

*United States Life Tables 1890, 1901, 1910, and 1901-1910.* Explanatory Text, Mathematical Theory, Computations, Graphs, and Original Statistics. Also Tables of United States Life Annuities, Life Tables of Foreign Countries, Mortality Tables of Insurance Companies. Prepared by JAMES W. GLOVER. Bureau of the Census 1921, pp. 1-496. 4to.

Since their appearance some years ago Glover's earlier United States Life Tables have been a standard reference work on mortality in this country. With characteristic thoroughness, the author has extended and improved his earlier work, and has produced what may well be regarded as, at the moment at least, *the* standard actuarial reference work. For it can be said that in this present volume so much of actuarial science as concerns itself with the construction of mortality tables is covered with meticulous attention to detail. Nothing is left to the imagination of the reader and little to his inelligence. Every point in regard to the construction and the interpretation of life tables which could possiby arise to puzzle a voyager into these placid, because carefully "smoothed" seas, is explained thoroughly, comprehensively, and completely, with copious illustrations domestic and foreign in origin.

This is as it should be. Life tables have had the quite undeserved reputation of being mysterious documents, capable of being understood only by the highest order of intellects. As a matter of fact they are, of course, nothing of the sort, but only a quite obvious and simple set of derivative functions from age specific death rates. Such an exposition of actuarial arts and science as Glover gives in this volume will most effectually remove from the mind of the careful reader any lurking notion that there is an element of the occult or transcendental in life tables, and will impress him with the simple virtues of these documents. He must, however, be a careful, by which is meant painstaking, reader, because no light or fantastic touches will cheer his way through the solid, substantial mass of lucent but lucubratory details.

To turn to technical matters, it may be said that in the construction of the United States tables (based upon Registration Area data variously subdivided demographically for three different periods) Glover has followed the most highly approved, orthodox actuarial methods. The $q_x$ values were smoothed between ages 5 and 85 by osculatory interpolation using fifth differences. The first 5 years of life were dealt with by a special method based upon German official procedure, and this section was welded

to the main portion by fourth difference interpolation formulas. The upper tail end of the curve was graduated by Wittstein's formula and welded to the main portion by the application of Spencer's 21-term formula. Glover felt it important to alter the raw figures as little as possible and apologizes in various places for little roughnesses in the tables, especially around junction or welding points.

Much might be said about the orthodox actuarial philosophy regarding the smoothing or graduation of raw data. The present reviewer finds himself in disagreement with some of it, looking at the whole matter from the broad standpoint of scientific methodology. But this is clearly not the place to enter upon a discussion of this mathematically recondite and emotionally delicate subject. Suffice it to say that the reviewer is acquainted with no more honest, through, and skillful application of the standard actuarial methods than that of Glover in the construction of these tables.

Altogether this is a substantial and notable contribution to American vital statistics. We may well be proud of it. It stands at least on a level with the very best that any country, not excepting the Registrar-General's Office of England and Wales, under Farr and Ogle and Stevenson, has produced in the same line. Every health officer and vital statistician should have a copy of it on his desk. Two features of the book are especially noteworthy. The first is that the best recent life tables for Australia, Denmark, England, France, Germany, Holland, India, Italy, Japan, Norway, Sweden, and Switzerland are given in full for comparative purposes. The second is that there are given, for the United States, tables of life annuities, premiums and commutations. This last is an interesting departure for an official government publication. Hitherto in litigation involving questions of life expectancy in the settlement of estates, etc., the courts have had to depend for their actuarial basis in the main upon the material of insurance companies. Now official tables based upon the experience of the original registration states in 1910 may be used, and all elements of uncertainty as to bias will be removed. Furthermore, by the use of the premium tables one can make intelligent examination of the alluring proposals made to him for the purchase of insurance, whether by theoretically grasping commercial institutions or by theoretically eleemosynary foundations.

Finally, it may be pointed out that this volume makes a first rate text-book for the systematic study of the basic elements of actuarial science. The reviewer is using it in this way at the present time, in a course in life table construction, with great satisfaction. It may be purchased from the Superintendent of Documents at a cost of $1.25 per copy, cloth bound, a price which is only a small fraction of what any commercial publisher would have to charge for a book so expensive to manufacture.

RAYMOND PEARL

## SPECIAL ARTICLES

### X-RAY CRYSTALLOMETRY: X-RAY WAVE LENGTHS, SPACE-LATTICE DIMENSIONS AND ATOMIC MASSES

THE fundamental equation in X-ray spectrometry and crystallometry is

$$\lambda = 2d \sin \theta$$

wherein $d$ is the perpendicular distance between adjacent planes in the crystal which reflect in the first order at a glancing angle of incidence $\theta$, X-rays of wave-length $\lambda$. Since only $\theta$ in this equation is capable of direct measurement the absolute magnitudes of $\lambda$ and $d$ can only be determined if some other relation between them can be found, or if either can be determined independently.

The method first used was to obtain a value of $d$ from the density of the crystal, the number of molecules in its unit of structure, and the mass of a single molecule. The first of the last-named quantities can be measured directly, the second is an integer the choice of which can be guided with sufficient accuracy from the X-ray data, and values for the third have been obtained by a variety of methods, perhaps best by the determination of electrochemical equivalents and electronic charge. No other relation between $\lambda$ and $d$ than that given above is at present known to exist, *i. e.*, no other quantity than $\theta$ is known to depend upon these two variables only, so that the first suggested method of

getting their absolute magnitudes is not feasible.

An independent method of getting $d$ is to employ the quantum relation between wave-length of X-rays and volts required to give electrons equivalent energy. In using this method we must take care to leave out of account those values of $h$ which themselves depend upon X-ray wave-lengths.

Using the first method we select the following data:

Number of molecules per mol, $N = 6.0594 \times 10^{23}$ (1, 5)
Density of calcite.....2.7116 gm/cm³ (2, 5)
Interaxial angle for calcite.....101°-55′ (3, 5)
Molecular weight $CaCO_3$.....100.07 (4)

The volume of the unit rhombohedron is $1.09626\ d^3$ and it contains one half of a molecule[6] so that the grating constant $d = 3.02855 \times 10^{-8}$ cm. The ratio of the grating constant of calcite, $d_{CaCO_3}$ to that of rocksalt, $d_{NaCl}$, has been determined by Uhler and Cooksey[7] and by Siegbahn[8], their respective values being $\frac{3.0307}{2.814} = 1.07701$, and $\frac{3.02904}{2.81400} = 1.076417$ ($\log^{-1} 0.0319806$), the latter of which is the more accurately determined and will be taken as the true ratio. This requires that $d_{NaCl}$ be changed to $2.81355 \times 10^{-8}$ cm. The values given by Duane[9] for these two constants are $3.028 \times 10^{-8}$ and $2.814 \times 10^{-8}$, the ratio of which, 1.07605, is probably a little low. To correct Duane's wave-lengths to the new basis we must multiply those based on $3.028 \times 10^{-8}$ for $d_{CaCO_3}$ by $\frac{3.02855}{3.02800} = 1.00018$, and those based on $2.814 \times 10^{-8}$ for $d_{NaCl}$ by $\frac{2.81355}{2.81400} = 0.99984$.

It should be noted further that Siegbahn[10] has more recently obtained a value for $\frac{\lambda}{d} = \sin\theta$ for the $K\alpha_1$ line of copper which does not agree with that which he obtained at the time the above-mentioned ratio was obtained. His new value for $\lambda$ is $1537.302 \times 10^{-11}$ for $d_{CaCO_3} = 3.02904 \times 10^{-8}$ as compared with the previous value $1537.36 \times 10^{-11}$ for $d_{CaCO_3} = 3.028 \times 10^{-8}$. Referred to the same basis (the new value of $d_{CaCO_3} = 3.02855 \times 10^{-8}$) this means a change from $1537.64 \times 10^{-11}$ to $1537.056 \times 10^{-11}$, a decrease of 0.038 per cent. Since this correction amounts to more than the difference involved in changing $3.028 \times 10^{-8}$ to $3.02855 \times 10^{-8}$ and $2.814 \times 10^{-8}$ to $2.81355 \times 10^{-8}$, and since Compton's value for the density of rock-salt has been criticized as probably too low[11] it seems premature on the basis of the above evidence to decide in favor of either of the two constants used by Duane.[12]

A recent note by Davey[13] bases a similar analysis upon a value of $N = 6.0642 \times 10^{23}$ and upon 2.173 gm/cm³ as the density of rock-salt, thus getting a spacing for the (100) planes in this crystal of only $2.810 \times 10^{-8}$ cm. Adoption of this value would require extensive correction of all reported wave-lengths without any considerable advantage, and observers agree that rock-salt is a less suitable standard than calcite, on account of the greater probability of inclusions leading to abnormally high densities. The density corresponding to the value here chosen for $d_{NaCl}$, $2.8135 \times 10^{-8}$,

[1] R. T. Birge, *Phys. Rev.*, (2), 14, 365 (1919).
[2] A. H. Compton, *Phys. Rev.* (2), 7, 646-685 (1916).
[3] P. Groth, *Chemische Kristallographie*, 2, 204 (1908).
[4] "International Atomic Weights," (1921).
[5] H. S. Uhler, *Phys. Rev.* (2), 12, 39-46 (1918).
[6] This is not a true unit of structure, which, however, is of no importance for these calculations; *cf.* R. W. G. Wyckoff, *Amer. Jour. Sci.*, 50, 317-360 (November, 1920).
[7] H. S. Uhler, C. D. Cooksey, *Phys. Rev.*, (2), 10, 645-652 (1917).
[8] M. Siegbahn, *Phil. Mag.*, (6), 37, 601-612, (1919).
[9] W. Duane, *Nat. Res. Counc. Bull.*, 1, 383-408 (November, 1920).
[10] M. Siegbahn, *Comptes Rendus*, 173, 1350-1352 (December 19, 1921).
[11] R. Ledoux-Lebard, A. Dauvillier, *Comptes Rendus*, 169, 965-967 (November 24, 1919); H. S. Uhler, *loc. cit.*5.
[12] *Loc. cit.*[9]; *cf.* M. Siegbahn, *Jahrb. d. Rad. u. Elektr.*, 18, 240-292 (1921).
[13] W. P. Davey, SCIENCE, 54, 497-498 (November 18, 1921).

and to $N = 6.0594 \times 10^{23}$, is 2.166 gm/cm$^3$ or only a little lower than the lowest value quoted by Davey.[14]

The value $N = 6.0594 \times 10^{23}$ is equivalent to a factor $1.65033 \times 10^{-24}$ ($\log^{-1} \bar{2}4.2175704$ for converting atomic or molecular weights to grams.

The second method, depending upon the value of $h$, requires in addition a determination of the potential applied to an X-ray tube. The work of Blake and Duane[15] may be considered as a determination of $d$ in terms of $h$. The values of $h$ collected by Birge[16] vary somewhat among themselves but $6.560 \times 10^{-27}$ seems a reasonable mean value of the results not depending upon X-ray wave-lengths, and this gives $d_{CaCO_3} = 3.0303 \times 10^{-8}$ or 0.058 per cent. higher than the value given above. This is within the range permitted by the probable error in the value of $h$ just taken.

The following constants are therefore recommended to be used until other values are agreed upon, to the accuracy indicated by the logarithms.

Grating space of calcite:

$3.028 \times 10^{-8}$ cm. ($\log^{-1} \bar{8}.48116$)

Number of molecules per mol:

$6.0594 \times 10^{23}$ ($\log^{-1}$ 23.78243)

Molybdenum K-radiation wave-lengths:

$\alpha_1$ $0.70783 \times 10^{-8}$ cm. ($\log^{-1} \bar{9}.84993$)

$\alpha_2$ $0.71212 \times 10^{-8}$ cm. ($\log^{-1} \bar{9}.85255$)

L. W. MCKEEHAN

RESEARCH LABORATORIES OF THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY, AND THE WESTERN ELECTRIC COMPANY, INCORPORATED,

SEPTEMBER 20, 1922

## PERIPHERAL MIGRATION OF A CENTRIOLE DERIVATIVE IN THE SPERMATOGENESIS OF ŒCANTHUS

IN 1920 Mr. Chas. S. Driver began at Columbia University a study of the male germ cells of a common tree-cricket, *Œcanthus nigricornis* Walker, an Orthopteron insect of the family *Gryllidæ*. His preliminary study convinced him that, during the changes undergone by the spermatid as it begins to lengthen into the mature sperm, the entire distal centrole migrates posteriorly along the axial thread, eventually forming a terminal "plug" for the caudal sheath at its distal extremity. While a peripheral migration of part of the central apparatus in the spermatids of invertebrates was not hitherto entirely unknown, previous accounts are few in number and somewhat conflicting in substance. A reexamination of this phenomenon was, therefore, of considerable interest. The untimely death of Mr. Driver left his work incomplete and his material was delivered to me for further study. Driver deserves much credit for the excellence of the preparations, which are remarkably well fixed and stained. The method of Benda was used for fixation, and the sections were stained according to the alizarin-crystal violet technique. My observations were made at a magnification of 1,100 to 1,650 diameters, somewhat higher than that used by Driver in his survey of the material.

After a careful study I have reached a different conclusion in regard to the migrating "centriole" from those of Driver and earlier observers. Although there is in the spermatids of Œcanthus a peripheral migration of a body which appears much like a centriole and stains in a similar manner, I am able to demonstrate that the migrating body is not an entire centriole, but only a portion or derivative of the distal centriole.

In early spermatids of Œcanthus the central apparatus appears as a bar which lies perpendicularly to the nuclear membrane. The axial thread has already appeared at this early stage. The bar constricts in the center, dividing into a proximal and a distal centriole. Almost immediately a small portion of the latter, encircling the axial thread, is budded off and begins a migration along the thread. As it moves distally it increases rapidly in size, and eventually becomes as large as both proximal and distal centrioles combined. It reaches a permanent position at the distal extremity of the caudal (mitochondrial) sheath. The remainder of the distal centriole continues to lie

[14] *Loc. cit.*,[13] assuming the value attributed to Retgers is 2.167 and not 1.167 as printed.

[15] F. C. Blake, W. Duane, *Phys. Rev.*, (2), 10, 624-637 (December, 1917).

[16] *Loc. cit.*[1]

in close proximity to the proximal one at the nuclear wall; and in cells too heavily stained with crystal violet they appear as a single body, a fact which may account for Driver's view that only the proximal centriole remains near the nucleus. A full account of the circumstances connected with the origin and migration of the distal centriole derivative will be incorporated in a later paper.

Accounts of a distal migration of a centriole or its derivatives in the spermatogenesis of invertebrates are, as already indicated, rare. Only among insects have such cases been recorded. Perhaps the clearest and most convincing statement is that of Otte ('07)[1] for *Locusta viridissima*. Some of his figures, notably No. 87 and No. 92, bear a strong superficial resemblance to certain cells to be found in the Œcanthus preparations. Otte, like most of the other observers of similar phenomena, considers the migrating body to be an entire distal centriole. My observations upon the origin of the migrating body in *Œcanthus* caused me to become skeptical of similar reports in other cases; and through the kindness of Dr. O. L. Mohr of the University of Kristiania, who has sent me testes of *Locusta viridissima* fixed in Benda's solution, I was enabled to make a re-examinaion of the spermatids of this insect. A preliminary survey of the material, while not entirely conclusive, indicates that the centrioles of the "neck-region" of young spermatids are two in number prior to, and throughout, the period in which the centriole-like body performs its migration to the posterior pole of the cell. This body, therefore, appears to be a centriole derivative and not the distal centriole itself.

The discovery in *Œcanthus* of a centriole derivative which migrates along the axial thread to a position remote from the nucleus is of interest because it presents certain transitional features between two previously known and common types of spermatid metamorphosis. The first of these types has been reported by numerous observers upon the spermatogenesis of various invertebrates, including most of the insects. In the early spermatids of these animals two centrioles lie together in the neck-region of the young spermatid. One of these, the distal centriole or blepharoplast, spins out an axial thread. The two centrioles remain practically unchanged in the same region throughout the metamorphosis of the spermatid, and no peripheral migration of centriole derivatives occurs. The second type is characteristic of certain vertebrates, notably the mammals, and has been described by various authors for man, rat, guinea-pig, *Phalangista*, etc. In the spermatids of these forms two centrioles also remain in the neck-region, but the distal, after spinning out the axial thread, cuts off a ring-shaped body which encircles the thread and migrates distally, at least as far as the terminus of the middle-piece. There is no well-defined middle-piece in the insect sperm, and, as already stated, the migrating body, closely analogous to that of the mammal sperm, passes to the posterior margin of the caudal sheath.

This study also has a bearing upon certain phases of the problem of fertilization, notably the origin of the first cleavage spindle. Many observers hold that the first cleavage centers arise from, or in the immediate neighborhood of, the neck-region of the sperm as it enters the egg. It is possible that the proximal and distal centrioles maintain their individuality and form each a pole of the spindle, but this must remain a matter of conjecture. It is noteworthy, however, that in practically every animal that has been critically studied,[2] portions of both proximal and distal centrioles pass into the neck-region of the mature sperm. In this respect Œcanthus falls directly into line with the vast majority, and probably also *Locusta*.

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[1] Otte, Heinrich: "Samenreifung und Samenbildung bei Locusta viridissima," *Zool. Jahrb.*, Bd. 24, Heft 3, S. 431-521, 1907.

[2] Apparently an exception obtains in certain Mollusca; *vide* Gatenby ('18): "The Cytoplasmic Inclusions of the Germ-Cells. Part III—The Spermatogenesis of Some Other Pulmonates." *Quart. Jour. Mic. Sci.*, N. S., Vol. 63, No. 250, pp. 197-258.

# SCIENCE SERVICE NEWS BULLETIN

The news bulletins prepared by Science Service will hereafter be printed as a supplement to SCIENCE. As most scientific men know, Science Service is a corporation not for profit whose capital has been provided by Mr. E. W. Scripps. The American Association for the Advancement of Science, The National Academy of Sciences and the National Research Council nominate a majority of the members and trustees.

The objects of Science Service are to supply current and interesting scientific information to as large a part of the general public as can be reached. The bulletins are not addressed primarily to men of science and might not be in place in the regular pages of SCIENCE. They will, however, prove to be of interest, partly because every one is at most an amateur in the sciences that are outside his own field, and partly because it is one of the objects of science to maintain its relations with the general public on which it must depend for recruits and for support.

It is hoped that the publication of Science Service Bulletins will prove to be interesting and profitable to scientific men and will lead to their cooperation in maintaining high scientific and literary standards in the popularization of science. It should be understood that while the editor of SCIENCE is responsible for the publication of the bulletins, responsibility for the contents rests with the editor of Science Service, Dr. E. E. Slosson, and the editor of the bulletin, Mr. Watson Davis, and in the last resort with the American Association for the Advancement of Science, the National Academy of Sciences and the National Research Council.

## MEASURES FEEBLE HEAT STARS SEND TO EARTH

BY measuring a hundred millionth degree of temperature and a trillionth of an ampere of electric current, Dr. C. G. Abbot, of the Smithsonian Institution, has determined for the first time the heat spectrum of starlight with great accuracy.

Working with the 100-inch telescope at Mt. Wilson Observatory this fall, Dr. Abbot measured the heat at different parts of the spectrum of ten stars and the sun. The rays were dispersed by a spectroscope in a band similar to the rainbow.

The bright star Capella, which is very similar to our own sun in its spectrum, was found to furnish the equivalent of one horse power to an area on the earth approximately equal to the state of Minnesota. But this prominent star is feeble compared with our sun, which is equal to a hundred billion Capellas and sends down on twenty square feet heat equal to a horse power. On the whole earth Capella's heat equals 500 horse power, and as all the stars together equal 500 Capellas this would amount to 250,000 horse power over the whole earth from the stars alone.

Dr. Abbot explained that his work on the heat of stars, accomplished with the cooperation of L. B. Aldrich of his staff, is an outgrowth of the principal work of the Astrophysical Observatory, which is the investigation of the sun.

"This work was begun about 1890 by Dr. S. P. Langley whose great pioneer work in measuring the sun's heat, its distribution in the spectrum, and the losses and modifications which it encounters in passing through the earth's atmosphere, were classic," said Dr. Abbot.

"It might be supposed that the investigation of a heat source whose in-put on the earth's surface amounts to the equivalent of a horse power per couple of square yards would require only simple and insensitive apparatus, but such is not the case. The complexity of the solar beam, made up of rays of greatly differing wave length which are all differently transmitted by the earth's atmosphere, requires the employment of the spectroscope to separate the rays, and for the recognition of their heat the use of highly sensitive thermometric apparatus.

"The most satisfactory heat instrument for these purposes is the bolometer, invented by Langley about 1880. Two hair-like wires of platinum are placed side by side, the one hidden from the rays by means of a metallic diaphragm, the other exposed in the spectrum. The heat absorbed by the exposed thread, if it be as little as the millionth of a degree, suffices to disturb a sensitive electrical balance, and by a beautiful device introduced by Langley in the earliest years at the Astrophysical Observatory these indications are

automatically recorded from one end of the spectrum to the other. The record takes the shape of a curve which mounts to different heights with reference to its base line, and these heights are proportional to the heat in the various rays of the spectrum. The absorption bands due to the chemical elements in the sun, and those due to some of the elements and compounds of gaseous nature in the earth's atmosphere, are indicated as depressions in this sinuous curve. In this way the effects of the earth's atmosphere upon the sun rays may be determined and allowed for, so that the intensity and quality of the rays as they would be outside the atmosphere, on the moon, for instance, where there is none, can be computed. When this is done, the intensity of the sun's heat freed from atmospheric influences is found to be variable."

The form of distribution of the solar spectrum gives an indication of the temperature of the sun. Just as the blacksmith's iron as he heats it becomes faintly glowing, then a brighter red, then yellowish, then white hot, so the spectra of the sun and other stars depend for the arrangement of the intensities of the different colors upon the temperatures which prevail in these sources of light. The measurements of the Smithsonian Institution indicate a temperature for the sun approximating 6,000 degrees C.

## NO SCIENTIFIC BASIS FOR PREDICTING CALIFORNIA QUAKE

THE fact that the earthquake zone in California is analogous geologically to the devastated region in Chile has raised some apprehension here as to the probability of a quake or tidal wave in California.

Since the disaster of 1906, considerable scientific research on the causes of the crust movements on the west coast has been conducted which may eventually lead to definite earthquake predictions.

But Dr. H. O. Wood, in charge of investigations for the Carnegie Institution of Washington, when seen at the Mount Wilson Observatory, said:

"There is no scientific basis for any estimate of probability of an earthquake in California following upon the recent shock in Chile. No indications of any impending shock have been noted here. Sometimes several great earthquakes have occurred in places far distant from one another within a relatively short time interval so as to suggest causal group occurrence but more commonly there is no such apparent grouping in the occurrence of great shocks."

About 150 miles off the coast of California, there is a sharp break in the ocean bottom that is as steep as the east slope of the Sierra Nevadas, according to Dr. William E. Ritter, director of the Scripps Institution for Biological Research, who located it by extensive soundings when he was on the oceanographic expedition of the *Albatross* in 1904. It has been suggested that this is a plane of weakness that might give rise to an earthquake at sea. Such a crustal slip would probably create a serious tidal wave such as that which swept the Chilean coast in the wake of the recent shocks.

But investigations into the history and folklore of the country are reassuring. They indicate that no tidal wave ever swept the California coast, according to Dr. Ritter. There is not even a tradition of sudden encroachment of the sea upon the land.

## HOW CHILEAN QUAKE HAPPENED

How Chile's death-dealing earthquake, which shattered cities and engulfed their helpless inhabitants with tremendous tidal waves, originated at sea off the coast of that country, is explained by Dr. W. J. Humphreys, meteorological physicist of the U. S. Weather Bureau, from the seismographic records made by the earth's tremors at this point. For four hours the pen of the highly sensitive instrument drew the picture of the movements in the earth, which wrought such havoc among the Chilean towns in a few minutes.

Earthquakes, Dr. Humphreys said, are produced by a slipping or breaking of the crust of the earth as a result of strains. These strains may be caused by the shrinking of the interior of the earth through temperature changes, changes in loads due to rapid erosion taking material from one place to another in the course of a few hundred years, or from the tendency of higher land to flow out to sea.

From what is known of the present quake, it seems to have been caused by higher land moving out to sea. The actual break in the crust occurred at some distance from shore, and this sudden change in the ocean floor at that point produced a tidal wave. As there were several such waves, there must have been several faults or breaks in the earth's crust at the sea bottom which created the different huge billows in the incompressible water. It is probable that this crack extended for a hundred miles or more and that the wave created was detected in the Philippines or other distant Pacific points.

Breaks, such as caused the shocks and waves

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Parts 1 and 2 (454 pp.) of Vol. IV. have appeared. Each volume costs 50 Belgian francs (about $3) (ed. de luxe, from vol. II on, 100 francs).

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in Chile, have left their mark on the physical geography of our own country. For instance there is a break in the earth's crust which can be seen at Great Falls, Va., near Washington. It has been traced from near Boston, Mass., through Pennsylvania and New York to the James River in southern Virginia. The Hudson River valley was created in the distant past by a similar slipping in the earth's crust.

An earthquake may occur anywhere on the earth's surface and no place is immune, yet they are most likely to happen at the present time in the newly formed geological regions such as are found along the western coast of South America, our own western coast, up to Alaska and down the other side of the Pacific by way of Japan, the Philippines, Java, and other islands in the South Pacific.

Because an earthquake occurs in one place is no indication that it will be followed by another in some other quakey regions. They do not run in series, unless the changes made in the load at one point may be so great as to cause additional strain at another place sufficient to cause a break. There are sometimes more shivers in the vicinity of an original break caused by further settling of the tremendous masses of rocks.

## PARAFFIN AND POISON PROTECT WOOD FROM TEREDO

DISCOVERY has been made of a way to seal poison in wood which promises complete protection for railroad ties, wharf piling, mining and ship timbers against the ravages of land and water creatures like the teredo. Dr. Paul Bartsch, curator of mollusks of the Smithsonian Institution at Washington, has found that by forcing hot paraffin containing copper or arsenic salts into timbers under pressure the wood can be preserved from damage by shipworms and other destructive forms of life. The method of application is the same as that now used in treating timber with creosote.

Heretofore it has been found hard to keep preservatives in the wood. Gradually the poisons leached out, and left the timber unproteced. By the use of paraffin, which is resistant to water, acids and alkalis, Dr. Bartsch claims this leaching can be overcome and the wood protected more effectively and with less expense than by present preservatives.

The Forest Products Laboratory reports that the hot paraffin solutions have a great penetrative power and blocks treated by the new method with iodides of copper and arsenic sealed in have been found by officers at the Key West Naval Station to be unaffected by ship worms after three months exposure in infested waters where the untreated wood to which they were attached was promptly attacked.

Dr. Bartsch now has a less expensive highly poisonous copper salt and is working to obtain a cheaper arsenic preparation, which he believes will eventually displace present timber preservatives. When the Panama Canal was built the greenheart wood was used in the lock gates on account of it being largely resistant to marine borers. Some difficulty was experienced in getting men to handle the wood, as on some it has an effect similar to that of our poison oak. Recently it has been found that even this toxic timber is attacked by the mollusks, which chisel out their homes inside it with impunity. They use the tooth-like edges of their shells.

A colony burrowing through the wood weakens the timber and often results in heavy piling being completely cut in two. Untreated wood shows the holes which the mollusk makes in three months and some creosoted timber after two years in the water has been found to be infested. Copper solutions of one in 2,000,000 have been found deadly, and Dr. Bartsch claims that when the tender tentacles of marine forms come in contact with his preparation they will curl up like the victim of a wood alcohol party. When the shipworm swallows impregnated sawdust his boring days will be promptly over.

Any number of poisons can probably be effectively kept in the wood by mixing them in the paraffin. So resistant is paraffin to the effect of acids that bottles are made of it to hold hydrofluoric acid, which eats through glass. Heat alone would melt it out, but for railroad ties a paraffin too hard to be affected by the sun's heat would be used.

## ALUMINUM SULPHATE MAKES RARE FLOWERS AND FRUIT THRIVE

MAGNIFICENT orchids and rhododendrons and gigantic blueberries can be grown in ordinary soil to which aluminum sulphate is added, Dr. Frederick V. Coville, chief botanist of the U. S. Department of Agriculture, has discovered. Such rare plants will not flourish in untreated soil that is alkaline.

The farmer applies lime to make his soil alkaline and capable of raising bumper yields of the common crops, but the nurseryman can now reverse the process and apply aluminum sulphate to make the soil acid and capable of raising blue-

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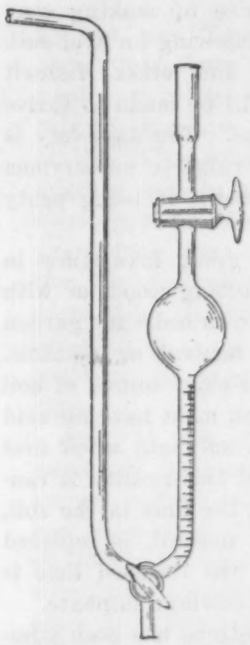

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berries, orchids and rhododendrons, if Dr. Coville's experiments are applied on a large scale with continued success.

This treatment gives promise of making easy the cultivation of all plants requiring an acid soil.

Orchids, azaleas, kalmias and other difficult plants, Dr. Coville believes, will be made to thrive in common soils by this means. The discovery is expected to prove of especial value to nurserymen in saving them from the necessity of using peaty lands to raise these flowers.

Rhododendrons grow with great luxuriance in sand mixed with peat, with rotting wood, or with half rotted leaves, but they die in ordinary garden soil because its reaction is neutral or alkaline. Partially rotted leaves are the chief source of soil acidity. And the rhododendron must have an acid soil. The alum or aluminum sulphate when first applied has an acid effect and this acidity is continued owing to the fact that the lime in the soil, which would tend to make it neutral, is replaced in the soil by aluminum and the released lime is leached away in the form of calcium sulphate.

The growth of the rhododendrons has been stimulated very greatly in this way. In one experiment, Dr. Coville placed three plants in the same sort of soil. One was untreated, another was treated with Epsom salts and one with aluminum sulphate. The untreated one failed to flourish. The Epsom salts treatment caused an increase in diameter of 30 per cent., while the increase due to the aluminum sulphate treatment was 250 per cent.

Most American crops are natives of alkaline or neutral soils, and for that reason the most prominent problem has been to prevent soil acidity by the addition of lime. This is the first time that an artificial means of converting an alkaline soil to acidity has been worked out.

## COLD WINTER COMING IS BEST WEATHER BET

THE coming winter will probably be a cold one, despite the heralded reports from Norway telling of warm weather in the Arctics.

Major E. H. Bowie, forecaster of the U. S. Weather Bureau, says that daily observations received by radio from Spitzbergen, Iceland, and Wrangel Island, as well as from the Amundsen Polar Expedition north of Alaska indicate temperature conditions contrary to those reported as prevailing in the eastern Arctic by Consul Ifft at Bergen, Norway.

The abnormally warm weather said to have been found in the eastern Arctic is not confirmed by the records received from stations in other sections of the Circle. Recently there was a big snow storm on Spitzbergen, and from Wrangel Island, beyond Bering Straits, reports of exceedingly low temperatures have been made since August.

About the coming winter, Major Bowie says that although meteorologists do not make definite long distance weather forecasts, the chances are that the approaching winter will be cold. The last two winters have been abnormally warm, and according to the law of probability it is unlikely that this winter will follow suit.

Whatever effect may have been produced by the possible greater speed of the equatorial currents carrying warm waters higher in the Arctic, as claimed from Norway, this is not likely to modify the winter in the Northern Hemisphere in general. U. S. Hydrographic officials here say they have received no reports tending to confirm this greater warmth of ocean current water and no unusual ice or water conditions have been found this season.

## ITEMS

TAXICABS in Havana use gasoline in preference to the much cheaper alcohol, because congested traffic conditions require quick starting ability.

MANY a rich Chinese merchant of to-day is waked up by an American alarm clock, talks over an American telephone, and rides in an American motor-car.

THE size and height of rooms in native houses in Japan are more standardized than the room-dimensions in the houses of any other country.

LONG continued exercise of white rats increases the weight of the heart, kidneys and liver, on an average of about twenty per cent.

NOBODY on earth has ever seen the other side of the moon, as that satellite always keeps the same face toward us.

IN 1921 the people of the United States spent ten dollars a person for candy, nine dollars for education, fifty cents for chewing-gum, and twenty-nine cents for health.

RHAZES, Persian physician of the tenth century, picked out the site for a hospital in Bagdad by hanging pieces of meat in different parts of the city in order to find the place least favorable to putrefaction.

NEARLY all the varieties of coffee plant in the western hemisphere are said to have sprung from one plant imported by the French at the island of Martinique in 1717.

# SCIENCE SERVICE NEWS BULLETIN

*Science Service, Washington, D. C.*[1]

## HELIUM HUNTING IN THE MILKY WAY

By Isabel M. Lewis,
U. S. Naval Observatory

Helium, our wonderful non-inflammable balloon gas, does more than lift airships without danger from explosion. Much is being learned of the size, structure and form of the universe by a study of the stars containing incandescent helium.

Stars of the helium type give light which when broken up by the spectroscope shows prominently the bright yellow lines of helium, indicating that this gas is present conspicuously in their atmosphere. They are excessively hot and massive and bluish-white in color, and they occur in abundance —often as double, triple or multiple stars enmeshed in nebulosity—in the constellation of Orion. Hence their name of Orion stars.

It was found some time ago that comparatively near us in space, that is, so near to our solar system that light traveling 186,000 miles per second would only take a few hundred years to reach it, there exists a local cluster or group of these helium stars in the constellation of Orion. In fact, our sun is a star in the Milky Way and within this extensive group. It is about fifty light years to the north of the central plane of that great galaxy.

Enormous dark tracts of nebulosity in that thickly star-strewn space, located in the constellations of Centaurus and Scorpio and shutting off light from stars beyond, lie between 650,000 and 975,000 light years from the solar system. This is about the greatest distance that has been found for any type of celestial object and shows how enormous is the extent of the Milky Way along its greatest axis.

Because all the helium stars in the Orion group are well within the range of vision of the naked eye or at most no fainter than stars of the seventh magnitude which lie just beyond the naked-eye vision, it was assumed that there were few, if any, fainter helium stars lying beyond this group.

Recent investigations made at the Harvard College Observatory and based upon data furnished by the new Henry Draper Catalogue, however, reveal that there are many faint helium stars beyond and independent of this local group. These fainter stars are confined closely to the vicinity of the Milky Way, lying within a belt only ten degrees wide on either side of it. Some of these stars must be at distances of thousands of light-years from the earth. It has been found also that the distribution of helium stars is not uniform along the Milky Way. In some regions they are grouped more densely than in others and the southern sky is particularly rich in stars of this class.

Just as the Columbuses and Magellans by means of their ships made voyages into the unknown regions of our earth and brought back new knowledge of the size and shape of the world on which we live, so these explorers of the skies with their spectroscopes seeking out the helium stars are adding to our knowledge of the star-lit universe of which our planet is a part.

## NEW MUSEUM INTERPRETS AMERICAN ABORIGINAL LIFE

New light from all directions breaks in upon the life of the aborigines of the Western World through the study of the vast collections of the Museum of the American Indian, Heye Foundation, New York, which was opened free to the general public November 15.

This is the only museum in the world devoted exclusively to the preservation of the records of the races which were living in the Western World when Columbus reached these shores, and contain 1,800,000 specimens. The great problems to which it is dedicated include the unveiling of the mystery of the origin of the so-called Red Men themselves. It is within the range of possibility, in the opinion of George G. Heye, the founder of the museum, that this goal will be reached.

The building of the Museum of the American Indian is situated in Broadway at 155th street, close to the museums of the Hispanic Society and of the American Numismatic Society and the quarters of the American Geographical Society. The rearing of the whole important group was due primarily to the zeal of Archer M. Huntington, who gave the site for the Museum of the American Indian and as one of its trustees gave liberally to its building fund.

[1] For a statement concerning Science Service and the reasons for printing its news bulletins in this place, see the issue of Science for November 24.

The specimens are shown on three of the four floors and at the top of the building is a commodious work room given to the cleaning and preparation of the collections for display. Although this museum is devoted to delving into the past, it is conducted in accordance with the principles of modern business efficiency. The installations are in the latest types of cases. Already the storage vaults in the basement are filled, and many of the bulky specimens which can not be shown at present, are housed in another building which is almost as large as the museum itself.

There is a novel system of installation, introduced for the first time in the United States, through which the public can see what is not in open view without asking for it. Under many cases, there are drawers which the visitors may pull out and view objects under their glass tops. The students and the research investigators also have access to the collections in storage, all of which have been systematically catalogued by the director himself. There is not a bit of bone or a potsherd in the whole institution which can not be instantly found for purposes of comparison and research.

If some one should come in with a fanciful theory that the Australian bushmen and the American Indians had some relationships because both used boomerangs, he would see that such a comparison did not hold good very far. The Indian rabbit stick is not a boomerang, although it looks a little like that famous weapon, because it really does not come back. Fact can thus be quickly separated from fancy by bringing the objects themselves quickly to the study of the investigator.

"The trustees of the Museum," said Mr. Heye, "wish to make it clear that the objects which are assembled here are of great practical value, aside from the historical and archeological interest attaching to them. This is realized, for instance, by many manufacturers of textiles who have been making use of ideas gained from our collections. They have been sending their designers here even before the museum was officially opened and they inform us that they have found the inspiration of many new designs that were adapted from what was seen here. We think also that the textile industry will find data to guide it in dyeing operations, as many of the objects here, centuries old, were dyed with vegetable colors which to all appearances are as fresh as they were when first applied. We believe also that, although modern machinery has outdistanced the Indian craftsmen in speed, the industries of the twentieth century will find many hints in the synoptic exhibitions of basketry, ceramics and carving which we have installed. In every way the desire to serve the public is uppermost."

The board of the museum consists of Harmon W. Hendricks, James B. Ford, F. Kingsbury Curtiss, Archer M. Huntington, Minor C. Keith, Clarence B. Moore, F. K. Seward, and Samuel Riker, Jr.; Mr. Heye, also a trustee, is chairman.

## AIRPLANE CAMERA SURVEYS MISSISSIPPI DELTA

For the first time the great delta of the Father of Waters, the Mississippi, has been surveyed with true accuracy, is announced by the U. S. Coast and Geodetic Survey. From the air, by using cameras, that great fan-shaped marshy region stretching 600 miles into the Gulf of Mexico was charted, and important shifts of land and water were discovered.

Formerly it was necessary to survey it from boats, using tall signals and special ladders and tripods, on account of the prevalence of marshes and tall vegetation. Much of it is inaccessible on foot. For these reasons the topography of this area has always been largely a matter of guesswork on the part of surveyors and engineers. A seaplane, camera and men were furnished for the survey by the navy, and pictures were taken of the delta from a height of 8,000 feet. Over a thousand photographs were subsequently formed into a mosaic or composite picture.

Many totally unknown lakes and ponds were discovered by the aviators. Old stream-beds and changes due to over-flowing banks could be traced. New sub-deltas were found that had formed since the last survey. Some places existing on the last chart have either ceased to exist or have altered completely in form.

The most important of these changes is in the vicinity of the South Pass, the main entrance to the river. Former surveys showed the west bank of this pass as a marshy area extending out into the gulf for a distance of over four miles. Now, according to this recent photographic mapping, it is merely a narrow strip, so narrow that it is giving the engineers considerable concern as a new "crevasse" may break through at any time, completely altering the mouth of the river.

Owing to the many forces constantly at work on the delta, changing the contour of the coast line, producing entirely new areas and completely wiping out others, it has been necessary to survey it frequently. With aerial photography, this can be accomplished in much less time and with more accuracy than by the old methods. As it is

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**By SIMON H. GAGE of Cornell University**
13th Edition, Published December, 1920
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a region of practically no difference in height such as would cause errors in scale, it is admirably suited to this method of surveying.

## VACCINE THROAT SPRAY FOR PNEUMONIA

IT may soon be possible to spray your throat and so become immune to pneumonia infection. Dr. Russell L. Cecil and Gustav I. Steffen of the Hygienic Laboratory of the U. S. Public Health Service, working at Bellevue Hospital in New York City, have completed experiments on monkeys that suggest that considerable immunity against virulent pneumonia can be obtained by the mere spraying of the throat with pneumococcus vaccine.

Monkeys can be completely protected against pneumonia by injections of the vaccine under the skin, and recent tests prove that injecting the vaccine directly into the trachea or windpipe, leading from larynx to lungs, is just as completely effective. Although throat spraying did not produce complete immunity in the case of monkeys, the bacteriologists believe that it may prove effective when used on a human being. They found that monkeys when having their throats sprayed closed the opening into the windpipe and the vaccine did not get a fair chance to act. The human trachea could easily be reached by the spray and immunity produced.

Protection against pneumonia produced by spraying or injection of vaccine into the windpipe probably extends only as far as the cells that would be first attached by the microbes producing pneumonia, as tests indicate that a protective substance is not formed in the blood as in the case of smallpox or similar immunization. Further tests to amplify the experimental data and perfect the methods are to be undertaken in order that practical use of protection against pneumonia can be achieved at the earliest possible time and the greatest possible safety.

During the war, Dr. Cecil and collaborators tested the prophylactic value of pneumococcus vaccine on recruits in the U. S. Army and found that the cases of pneumonia were few in the organizations that were treated with vaccine injections under the skin. There were some severe reactions at the time of the inoculations, however, and further research was thought advisable before active immunization against pneumonia would be practical in civil life. For this reason experiments leading to the spraying method were undertaken.

The vaccine used consists of a salt solution suspension of killed pneumococci, the microbes that produce pneumonia. As many as 120,000,000,000 pneumococci are used in a single vaccination experiment.

In 1920 pneumonia was responsible for 137.3 deaths out of every 100,000 people in the United States, and in fatality it was outranked by only tuberculosis and organic heart disease. In 1918, when influenza deaths mounted to the high total of 300.8 per 100,000, frequent pneumonia as an after effect caused a pneumonia death rate in that year of 286.2.

Through the use of pneumococcus vaccine and further experimentation, it is probable that these high rates will be greatly reduced when the vaccination against pneumonia is practiced widely. Eventually it may even be possible to control this respiratory disease as completely as smallpox, public health experts believe.

## GLUCOSE RECOMMENDED AS AUTO RADIATOR ANTI-FREEZE CHEMICAL

GLUCOSE is recommended as a preventive of automobile radiator freezing by Dr. Charles H. LaWall, Department of Theoretical Pharmacy, Philadelphia College of Pharmacy and Science. "For four winters past I have successfully employed commercial glucose with unquestioned efficacy and with no detrimental results whatever," explaned Dr. LeWall.

He believes that glucose is superior to anti-freezing mixtures containing denatured or wood alcohol, glycerine, or some chemical salt such as calcium chloride. The ordinary confectioners' white glucose is preferred, although on one occasion he used the glucose sold for table use.

The amount necessary is between 15 and 20 per cent. or about a pint and a half of glucose to a gallon of water. The glucose may be mixed with enough warm water to completely dissolve it and then added to the remainder of the water in the radiator. No further addition or attention is necessary except to replace the water lost by evaporation. When warm weather arrives the radiator should be emptied, rinsed out and filled up with plain water.

"In addition to using the mixture practically for four years with satisfactory results I also performed some experiments to determine the congealing point of such a mixture," said Dr. LaWall. "I found that it begins to get slushy at about 10 degrees above zero Fahrenheit, but that it does not actually freeze and harden even at 6 degrees below zero Fahrenheit."

"Glucose does not corrode nor affect metals; in fact, it prevents such action by virtue of its

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chemical reducing properties. It seems to have no effect upon rubber in the dilution used; at least, I have never had to replace my rubber hose connections. There are no objections to glucose at all that I have found and its inexpensiveness and the freedom from the annoyance of constantly having to replace a volatile solvent such as alcohol are unquestioned advantages.''

## FUMIGATING GAS WAVES ITS OWN RED LANTERN

A NEW fumigating gas which saves human lives by giving warning of its presence has been developed by the U. S. Public Health Service in cooperation with the Chemical Warfare Service of the War Department, it is announced by a board appointed to investigate ship fumigation. It will be used in ridding ships, cars and houses of rats, bedbugs, lice and other insects.

Hydrocyanic acid gas, the fumigant now used, has occasionally cost human lives because of lack of odor, although by killing disease-carrying vermin it has prevented serious epidemics from sweeping over the country.

The weeping is done by the potential victim, not by his relatives, when the new gas is used, the expert explained. Cyanogen chloride, a very active tear gas and a by-product of war work, is mixed with the hydrocyanic acid gas to form the new combination for fumigating use. The new poison is easily detected as doses too weak to deliver a knockout produce severe weeping. It is harmless to foods, tobacco, fabrics, leather, and has no corrosive action on metals that may be on board. The gas does its work quickly and then dissipates rapidly. It costs but little more than the fumigants which are more dangerous to handle.

Hydrocyanic acid gas and sulphur dioxide are the gases which have been used largely in ship fumigation, the board's report explained. Sulphur dioxide, although it gives warning of its presence in time to allow the escape of any person within the quarters where it is used, is costly, harmful to clothing and foodstuffs, and requires from 5 to 12 hours exposure. Hydrocyanic acid gas is cheaper and more poisonous than the sulphur dioxide and does not affect food, clothing, or other articles. But it is odorless and non-irritating and leads to fatalities due to failure to detect its presence in time.

## COMBINED DYES KILL BACTERIA

''DYE bacteria and they die'' is one way of expressing a discovery that Professor John W. Churchman, of Yale University, and surgeon-in-chief of the New Haven Hospital, has reported to the National Academy of Sciences.

''Different kinds of aniline dyes have high bactericidal power,'' Dr. Churchman said. ''By mixing two kinds of dyes of opposite selective power a mixture results that readily kills all bacteria. The two dyes may be used together in a mixture of this kind, and the strength of one fortifies the weakness of the other. This establishes a new principle in dye therapeutics.''

In 1912 Dr. Churchman discovered that the dye, called gentian violet, kills certain kinds of bacteria even when it is as weak as one part in a million. This fact was applied in treating many kinds of infections.

Now Dr. Churchman has announced the finding of another aniline dye, acid fuchsin, which kills the bacteria which the gentian violet spares and spares those which the gentian violet kills. The mixture of the two dyes, which has a royal purple color, spares none of the bacteria.

''Contrary to what is usually held, dyes may be effective against bacteria even though they do not stain them,'' he said. ''Bacteria may also be stained by dyes without injury.''

He has shown, moreover, that the mechanism by which dyes ''kill'' bacteria depends not on their ability really to kill them, but to paralyze their reproductive capacity.

## ITEMS

AN American, William Wheelwright, introduced the telegraphic system into Chili, and organized the first steamship service between the west coast of South America and Europe.

MANY rice crops of the South to-day are directly descended from a pocketful of rice smuggled out of Italy by Thomas Jefferson.

THOMAS JEFFERSON, author of the Declaration of Independence, and third president of the United States, was also an astronomer, physicist, engineer, anatomist, geologist, zoologist, botanist and paleontologist.

LEONARDO DA VINCI, famous painter of the woman with the million-dollar smile, was the best physiologist of his time and made anatomical drawing of human bodies which he dissected with his own hands.

THE United States imported 43,365,763 bunches of bananas in 1921, but this fruit was once sold in this country as a tropical curiosity at ten cents apiece with each individual banana wrapped in tin foil.

# SCIENCE NEWS

## LIFE ORIGINATED WHERE TIDES EBB AND FLOW

*Science Service*

In a shallow brackish water, warmed by the sun to temperatures such as occur in tidepools of to-day, the forerunners of living things as we knew them must have originated, Dr. D. T. MacDougal, director of the department of botanical research of the Carnegie Institution of Washington, told the Royal Canadian Institute in describing what the scientist knows of the beginnings of life.

"The first form of life on this globe must have been minute masses of primordial jellies," said Dr. MacDougal. "The beginnings of life could not have been in the monotonus immensity of the seas, which are really a uniformly salt solution with but minute variations. Where the sea met the land, however, many new combinations were possible. There was no soil on the land, for this is a product of plants and animals. The landscape was of bare rocks, sand and water. Rapid alternations of sunshine and clouds with abundant rains would have characterized such a time, and volcanoes may have belched out earth encircling volumes of ashes and gases, some of which would come down with the rains. Hydrocarbons, ammonia, hydrogen phosphide and other necessary compounds might thus have been brought together accidentally but frequently with the result that there may have been formed countless masses of matter which might have become the basis of changes upon which life might be developed.

"In any case the compounds formed, which might have been jellies, did not fall into the way of beginning life as we know it until it became the seat of changes by which organic compounds were formed. For this to have happened, the colloidal or jelly condition must be assumed. This formation of additional masses of jelly and retaining them would go on until a certain size was reached, when fission or division would ensue as a drop of water too large divides into two smaller ones. This would have been the beginnings of growth and reproduction which are today the fundamental phases of biology."

The basis of all life from moss to men is protoplasm, a jelly-like substance, said Dr. MacDougal. The way in which this delicate jelly acts is universal, but its make-up is infinitely complex, although all protoplasm is made up of four general classes of substances, albumins, gums or mucilages, lipoids or fatty substances, and soaps.

"Somewhere in the ever more complex web of life the sun-traps or screens of coloring matter, which absorb and use the energy of certain rays of light in running the protoplasmic mill of plant life were made," said Dr. MacDougal. "These may have been of various colors, absorbing different patterns of the spectrum. The type of screen which has survived is that of leaf-green or chlorophyll. The chlorophyll of the plant cell absorbs radiations of certain wavelengths and the derived energy is ultimately used in the formation of sugars, and other chemical combinations. Transformations quickly follow, which result in nitrogenous substances. These products of the leaf mill are absolutely fundamental to the existence of the living world.

"The formation of coal beds was the final result of this photosynthesis of bygone ages, and when the accumulated remains of millions of years of the activity of vegetation is used the race will face the sternest necessity which it has yet encountered. We may discover other coal deposits, find new subterranean lakes of oil, get gasoline from shales, make use of corn cobs and seaweed, convert the power of our streams and harness the tides, but these are but petty economies deferring the day when, all of these proving inadequate, the major activities of the race, civilization in its present movement, and indeed the actual existence of man, will depend upon direct use of the energy of sunlight."

## CIVILIZATION MUST FAIL UNLESS SOLAR ENERGY IS UTILIZED

*Science Service*

Our great civilization is "a most squandrous and profligate one and is using the principal of its legacy in numberless new ways," Dr. H. A. Spoehr will declare in the forthcoming issue of the *Journal of Industrial and Engineering Chemistry*. Dr. Spoehr has been working for many years at Carmel, California, in the Coastal Laboratory of the Carnegie Institution of Washington, on the question of how plants are able to make use of the energy of the sun's rays, and he has come to the conclusion that the solution of

this problem is the task of the twentieth century and demands the cooperative effort of scientists in all fields.

"The destiny of civilization is guided by and reflects the amount of available energy," Dr. Spoehr will say. "When coal and oil are exhausted the daily ration of solar energy will represent almost the entire means of livelihood; our mushroom civilization must pass like the historic empires of the past and we may expect the reappearance in the world once more of galley slaves and serfs."

There is as yet no adequate substitute known for the fossil fuel that we have been using so lavishly during the last half century. A year's consumption of coal at the present rate represents the accumulation of hundreds of years. The date of depletion of the petroleum supply of the United States is clearly in sight. Water power would be insufficient, even if we could use every drop that fell in the country for running machinery. Alcohol seems the most promising substitute for mineral oils as a motor fuel and this can be made in any quantity by the fermentation of various kinds of vegetable matter. But this in any case requires the setting aside of large areas of land for the purpose. If, for instance, corn were to be used for the manufacture of fuel alcohol it would require more than four states the size of Ohio to grow the corn necessary to produce the seven and a half billion gallons of alcohol that would be needed to replace the five billion gallons of gasoline now consumed annually. But we can not afford to reduce our food to furnish our fuel.

Nature's method of utilizing solar energy by means of the green leaf is, as Dr. Spoehr will point out, "exceedingly inefficient and wasteful." But "it is the duty of the scientist to learn the precise manner in which this is accomplished. He need not be timid about competing with nature. He has many cases to his credit of surpassing the processes of nature both in efficiency and reliability. The most promising outlook for success in this field would be offered through an organization by which information from the various allied fields can be collected and focussed on the chemical and energy changes taking place in the process of photosynthesis."

## PEAT MAY SERVE AS LOCAL EMERGENCY FUEL

*Science Service*

FACING a cold winter with many consumers none too certain of their coal supply, the country has had its attention called to the fuel resources of the country as never before. People who have thought of peat as a product of the bogs of Ireland and a poor substitute for wood and coal are beginning to learn that this excellent fuel lies in rich deposits in New England and the lake states, the very regions expected to be hardest hit by the present coal shortage.

About 20,000,000 tons of peat are used in Europe every year, but in the United States there are deposits estimated to contain 14,000,000,000 tons, an amount sufficient to supply Europe's present annual rate of use of this material for 700 years, it has been estimated by geological experts.

A large part of this peat is well adapted to power production or for use at the bog for the generation of electricity. The enormous deposits in New England could be used by the lime and textile industries cheaper than coal, experts believe, while those private consumers living near the peat fields could be economically supplied with peat for open grate fires, fall and spring furnace fuel, kindling and auxiliary fuel for use with coal during the severe winter months, and cooking range fuel.

Peat represents the arrested decay of vegetable matter. When plant remains fall upon drained soil they are promptly attacked by bacteria and soon disappear, but when the plant falls into water the change is different from decay when exposed to air. The acids formed slow up the decay by destroying the bacteria.

Peat is produced by this arresting of the decomposition of roots, trunks of trees, twigs, shrubs, mosses and other vegetation saturated or covered with water. It contains a large proportion of the carbon of the original plant material. It is almost always a surface deposit, formed under conditions favorable to luxuriant growth of plants and their incomplete decay.

Most coals were once peats, but it does not follow that the peats will necessarily become coal in course of time. When the peat is formed, carbonization is largely stopped, unless it starts again and the peat bed is buried beneath muds, sandstones, limestones, or other deposits of sediment and subjected to heat and pressure, coal will not be created. A twelve or fourteen inch seam of coal is equivalent to a good peat bog twenty feet deep. The largest peat deposit in this country is in Minnesota and covers nearly 4,000 square miles or about 2,500,000 acres.

This fuel has a higher heat value than wood, is more easily ignited than coal, requires less

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draught. Peat burns freely when dry, and makes a hot fire. It is lower in heat value per pound than coal but it gives out proportionately more heat, due to its relatively higher oxygen content.

There is no soot from a peat fire, but if not handled properly a light smoke carrying the odor of burning leaves may get into the room. Peat makes fine kindling for a hard coal fire and is especially good to wake up such a fire quickly without shaking down the furnace. If a few blocks of peat are thrown on top of the fire and the draughts opened, surprising results are obtained.

Too much of this fuel should not be put on at a time. Peat is about twice as bulky as coal and can not be transported long distances at a price that is economical, but it does offer a good emergency substitute for coal and is especially useful as a supplementary fuel for use with coal.

## OYSTER CHANGES SEX THREE TIMES A YEAR

*Science Service*

THE remarkable and long disputed changes in the sex of the edible oyster are settled by researches of Dr. J. H. Orton, of the British Marine Biological Association at Plymouth, and Dr. R. Sparck, of the Danish Biological Station at Limfjord. Working independently, both these naturalists announced that these bivalves may be male, then female, then male again all within one year. The rate of change, Dr. Sparck believes, depends largely upon the temperature of the water.

The oyster either never has possessed, or more probably has discarded, all the trappings of sex. There is a single genital gland and a single duct. At one time male cells are produced and discharged into the sea-water in clouds. At another time egg cells are produced and are fertilized by male cells drawn in from the surrounding water.

There is no difference in the external appearance of the oyster in its male and female phases, although if the shells be opened, microscopical examination of the sexual gland shows the difference between mobile sperm cells and the large inactive egg cells. When it is sexually mature for the first time the oyster is male. Next, after a varying period, it becomes a female, and very soon after the discharge of the embryos it again begins to liberate male cells. One oyster has been known to change three times in a single season.

Dr. Sparck, however, thinks that the duration of the male stage depends on the temperature. The colder it is the longer the male stage lasts. The oysters in Southern Europe have been found to begin breeding at an earlier age than those of Northern Europe. Oysters in the northern waters can produce young only every third or fourth year, and therefore only three or four times in their whole life.

## USEFUL POWDERS FROM WASTE LIQUIDS

*A. C. S. News Service*

THE atomizer has gone into business for itself and is making big dividends out of wastes. Such evil-looking liquids as the greasy waters from fish oil plants, waste sulfite liquors from paper mills, and the waters in which raw-wool has been washed, yield wealth when forced through the atomizer.

Walter H. Dickerson, a member of the New York Section of the American Chemical Society, gives a description of the recently invented machinery which reduces materials from a liquid to a dry powder condition. The process is described, briefly, as one of "reducing the material to be dried to a finely divided state by spraying or atomizing; exposing the spray to heated air or gas and quickly effecting the evaporation of the moisture contents."

Mr. Dickerson believes that some day the Chicago River may be run through such a machine, to the greater beauty of the stream itself and to good economic advantage. "Indeed, this would be entirely possible and advantageous," said he, "if the waste heat that escapes up the flues of manufacturing plants in the industrial district of Chicago near the river could be utilized for drying operations."

In paper manufacture, chemists have found, only about fifty per cent. of the wood used in making pulp goes into the paper. The remaining portion of the wood passes off in the waste waters from the plant. Analyses showed that these waste waters contained high proportions of lignin—the adhesive material in wood. This is not required in paper but is very useful for the making of binders—cores for use in making molds used in foundries, and in making coal briquettes. The spray drying process makes the recovery of the lignin a profitable operation.

The waste waters from fish oil plants yield materials good for fertilizer and for poultry food. Waste waters from wool cleansing plants give grease, nitrogen and potash. Other industrial uses of the process include a new method of making starch, in that it can be reduced to the form of fine powder, through the atomizer and

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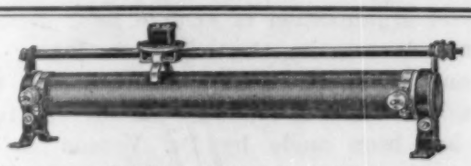

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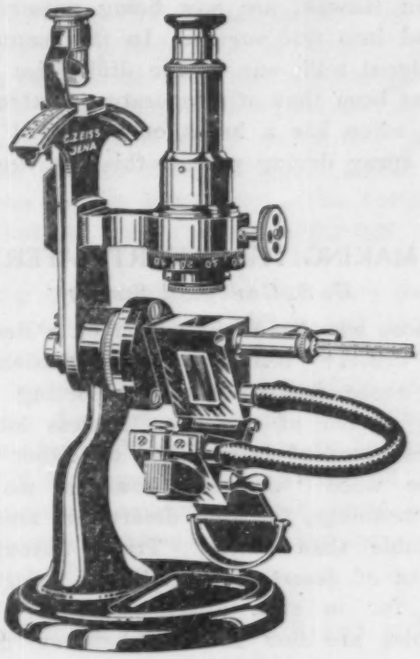

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drier, cheaper and faster than by old methods of drying.

Wastes from the sugar mills of Cuba and Louisiana are being made into stock foods and the pineapple juices which heretofore were allowed to run into the ocean from the canning plants in Hawaii, are now being preserved and converted into fine sugars. In the manufacture of powdered milk one of the difficulties encountered has been that of temperature control. The product often has a burnt or "caramel" taste. By the spray drying process this has been eliminated.

## MAKING THE DESERT SAFER

*U. S. Geological Survey*

To those who have never been on a desert the word "desert" conveys the impression of a barren waste incapable of supporting life, a perilous stretch of waterless, lifeless land that separates areas of fertile land on either side of it. The word "desert," however, may have diverse meanings, for some deserts are much more inhospitable than others. Travel through any wide area of desert is nevertheless fraught with danger, for in such areas springs, wells and water-holes are few and far between, and our American deserts have, year after year, taken their toll of human life. The recent work of the United States Geological Survey in mapping certain desert areas in the southwest and in erecting at suitable places signposts giving directions and distances to springs and waterholes is therefore of special interest. In 1917 the Geological Survey, under authority contained in an act of Congress making a small special appropriation, erected signposts in the most dangerous parts of our southwestern deserts, giving directions and distances from watering place to watering place. The results of this life-saving work of the Geological Survey are being published in a series of guidebooks.

One of these guidebooks, the third of the series, by C. P. Ross, has just been published. It describes desert watering places in the lower Gila region, Arizona, including approximately the triangular area between Phoenix, Yuma and Parker. It contains three large maps of the region, shaded to indicate the relief and showing the location of the roads, the wells, springs and other watering places, and the signposts erected by the Geological Survey. The maps are the most complete and accurate yet published for this region. The relief shading brings out strongly the larger features of the topography and makes the maps readily understandable, even by those who have no technical training.

The paper contains detailed logs of the roads in the region, including not only those of the principal automobile routes but those of branch roads that lead to remote parts of the desert, which are seldom visited and little known. These logs show in heavy type the points at which water can be obtained. There is also a list of watering places, with brief information as to their location and availability.

The introductory part of the guidebook contains detailed information regarding difficulties encountered in traveling through the desert and suggestions for surmounting them. Any one who intends to travel in this region should consult one of these guidebooks. Copies of this publication, which is numbered Water-Supply Paper 490-C, and entitled "Routes to desert watering places in the lower Gila region, Arizona," have been sent to the post offices, the chambers of commerce, and the principal hotels and garages in the region and can be consulted at many of these places."

## SCIENCE ITEMS

*Science Service*

DENIAL of a rumor spreading through this country that the International Research Council, the world organization of science, took action at its Brussels meeting last July excluding Germans and Austrians from its meetings and those of the international affiliated unions for twelve years has been made by Dr. Vernon Kellogg, permanent secretary of the National Research Council, which represents the international organization in America. "No such action was proposed or taken," said Dr. Kellogg. "No German or Austrian organizations have as yet been admitted to the International Research Council, but their admission is probably a matter of the near future."

SCOTS realize that the ladies will have their furs and that the trappers can not keep up with the demand. Silver fox raising which was started in Ross-shire two years ago has proved a success and the new industry will be extended. The Highlanders may seem personally partial to bare knees, but their well-known racial thrift convinces them that the fashion for furs should be catered to. The Scottish Board of Agriculture is encouraging the fox breeding.

IN order to prevent the spread of the bubonic and other plagues carried by rat-fleas, 330,000 rats have been captured and examined at Sydney.

# SCIENCE NEWS

## ALL STARS PROBABLY HAVE SAME COMPOSITION

*Science Service*

CONTRARY to what has formerly been supposed, hot stars and cool stars probably are very nearly the same in chemical composition, Dr. Henry Norris Russell, director of the Princeton University Observatory and research associate of the Mount Wilson Observatory, declared in an address before the Carnegie Institution of Washington here tonight.

"Recent physical research has told us so much about the properties of atoms that we have come to a new understanding of what we observe in the stars," said Dr. Russell. "Our knowledge of the composition of the stars depends upon the lines which we observe in their spectrum and which show the presence of many of the familiar chemical elements.

"The atmosphere of the cooler stars are full of the vapors of metals, while in the hottest stars the metals seem almost to disappear and to be replaced by gases such as nitrogen and helium. It has been supposed that this means that the stars differ in chemical composition, or that atoms of one kind are changed into those of another kind at such high temperatures; but in the laboratory we can subject atoms to far more violent treatment than they receive in the atmosphere of the stars without the least sign of their changing into atoms of other sorts. We can, however, knock one or two electrons off the atoms, and each time an electron is removed the spectrum of the light given by the atom changes entirely. After two or three such changes there are practically no lines left in the accessible part of the spectrum, though there may be strong radiations of ultra violet light or X-rays."

Dr. Russell said that in the hotter stars the atoms of the metals are in this condition and though still present, do not reveal themselves to the spectroscope. On the other hand, he said, gases like helium are so hard to set shining that it is only in the hotter stars that we can tell that they are there. The most abundant elements, such as hydrogen, show their presence when less abundant ones would disappear.

"This theory of ionization makes it probable that all the stars are very similar in actual composition—the observed differences arising from differences in the state in which the atoms find themselves in their atmospheres," he concluded. "On these principles it is already possible to reach conclusions about the temperature and pressures in the atmospheres of the stars. The pressures seem almost always to be very low and the gas so rarified that we would almost call it a vacuum in the laboratory. The temperature in the hottest stars probably reaches 25,000 degrees."

Deep in the interior of the stars the temperatures are enormously higher and are probably millions of degrees, Dr. Russell estimated. Here it is possible that once in a while atoms of one element do become changed into atoms of another kind. There is reason to believe, he said, that if hydrogen atoms are changed into others an enormous amount of heat would be set free, which would suffice to keep the stars shining for billions of years.

## TRACES OF CHEMICALS DO GOOD AND HARM

*Science Service*

NEGLIGIBLE traces or impurities may mar or make a chemical process or a product, Jerome Alexander, consulting engineer of New York, told the American Institute of Chemical Engineers at its annual meeting.

The Germans scrapped their own poison gas plant when they learned how the British made their "mustard gas" or diethyldichlorsulfide during the war by analyzing it and determining its impurities, he explained in labeling such traces telltales.

"Among the traces that help are vitamines," he said. "Also the value of traces of salts in water, for brewing, baking and other operations, is beginning to be appreciated, and we hear now of these being specially added. While 0.216 per cent. of arsenic reduces the conductivity of copper 39 per cent., pure copper rolls much less readily than that containing arsenic, and yields tubes that corrode ten times more rapidly. A little lead in brass makes it machine easily and prevents chattering. The reputation of Swedish iron is due to the manganese impurities it contains. A little copper inhibits the corrosion of steel. Small quantities of barium harden lead and make it ring like a bell. In many alloys

small quantities of aluminum deoxidize the melt and prevent atmospheric corrosion of the casting. In the electrodeposition of metals small quantities of 'addition compounds' which are in many cases protective colloids, give a desirable cathodic deposit. Auer von Welsbach found the great effect produced by ceria in the thoria mantle, the optimum value being about 1 per cent. Thus in a certain flame a pure thoria mantle gives 7 candle power, whereas the standard mantle with 1 per cent. ceria gives 88 candle power. With ¼ per cent. ceria the luminosity sinks to 56 candle power, while with 5 per cent. ceria it is only 44 candle power. Goodyear had no trouble in vulcanizing his rubber because of the various nitrogenous impurities present in the crude product of his day. With the advent of modern pure plantation rubber, it has become necessary to add various accelerators. Old patents show that celluloid dissolved in the "wood spirits" of that day, which contained ketones in considerable quantity, but refined wood alcohol is not a solvent for it. Traces of lead tetra-ethyl will take the 'gasoline knock' out of an internal combustion engine, even 0.06 per cent. being effective."

But other traces hinder rather than help, Mr. Alexander said. Iron was described as powerful in small amounts. A manufacturer of brewing sugar came to see how his new product was working in a brewery and found the brew-master running an inky black liquid into the sewer, he related. Being a chemist, he immediately wired his analytical department that their product was full of iron, and in reply received a telegram saying that the batch complained of had only 0.002 per cent. of iron. But that was enough to make plenty of ink with the hop tannins.

"In making dry batteries, traces of iron in the pyrolusite or of copper in the ammonium chloride are highly objectionable," he said, giving further examples. "One part of sulfur per million in cocoanut oil is said to create trouble in the soap making process. In lead burning traces of arsenic in the hydrogen used to make it impossible to secure a good joint. Attempts to make a good nickel steel were for years frustrated by impurities present in the commercial nickel of the day."

## PLAGUE RATS MENACE HAWAII; BUT POISON CAKES COMBAT THEM

*Science Service*

LIVES and fortunes are the stake in a tremendous war against field rats now being conducted by the territorial board of health and the sugar plantations of the Hawaiian Islands. The results of this war are likely to be of assistance throughout the world in campaigns against the rat, one of the worst enemies of mankind.

It is stated by those who have studied the problem at the experiment station of the Hawaiian Sugar Planters' Association that the common field rat destroys sugar cane on these islands valued at $100,000 each year, and probably the damage is in excess of this sum.

Worse than this huge tax on the industry, however, is the ever present danger of bubonic plague from infected rats. Twelve deaths among Japanese and Filipino plantation laborers occurred within the past few months on the Hamakua coast, island of Hawaii.

A new and successful method for wholesale killing of rats has just been discovered. Poison rat-cakes are being manufactured by the millions at Honokaa plantation and are spread broadcast through more than ten thousand acres of cane fields and waste areas, resulting in the death of so many rats that where the board of health previously trapped over two thousand rats a month, it now catches only about fifty.

The poison used is barium carbonate, deadly to rats and field mice, but only slightly poisonous to human beings, livestock and poultry. The poison is mixed with flour dough and made into small round cakes less than an inch in diameter and about one fourth inch thick.

A new and very important feature, for which patents have been applied, is the coating of paraffine over the cakes to protect them from dampness and moulding, thus insuring their effectiveness for many months. A very small nibble at one of these poison cakes will kill a mouse, while a piece as large as a small pea will kill a rat. Honokaa Sugar Company is manufacturing these rat-cakes chiefly for its own use, but it is also selling some at nominal cost for trial use on other plantations.

A man on horseback, dropping a rat-cake about every ten feet, can cover an area of 35 acres in one day, at a total cost of sixteen cents per acre. This done two or three times a year is sufficient to control thoroughly this very serious pest.

Other poisons have been tried at Honokaa. The best of these is strychnine wheat placed in small bamboo tubes and wrapped with paraffine paper. The usual methods of poisoning are intended for use on a small scale and no effective system has been evolved previously which is cheap enough to use over large areas and impervious to the weather.

Many efforts were made along other lines before

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poisoning was decided upon as the one effective plan. The U. S. army stationed in the islands had offered assistance in the way of poison gas experiments, as it realized the seriousness of the plague situation.

C. E. Pemberton, assistant entomologist at the sugar planters' experiment station, was assigned to investigate this possible means of control, but he reported:

"The use of gas in any form for combatting rats in the cane fields is wholly impracticable. Rat burrows, deep, extensive and permanent, are common, but extremely difficult to find until the cane has been cut and the trash burned. By then the rats have left the burrows. A minute search in any field, before harvesting, would reveal most of the rat burrows present, but the time required for such work would be far too great to warrant such a procedure."

Trapping was also experimented with and found unsuitable for use over so large an area.

The board of health is leaving the experimental work to the sugar planters, and is using its energies in cleaning up rat infested places in the labor camps. The people of Hamakua are giving the board every assistance in ridding the district of the menace. Camps are being cleaned up, rubbish is being burned and intensive trapping is conducted around houses and barns. All stray dogs and cats have been killed as it has been found that they also are capable of carrying the plague.

## MESOTHORIUM

*U. S. Bureau of Mines*

THE chemistry of mesothorium, the radio-active element found in monazite sand and other thorium minerals, which is used as a substitute for radium in the manufacture of certain luminous paints and for medicinal purposes, is discussed in Technical Paper 265,byHerman Schlundt, just issued by the United States Bureau of Mines.

Among the thirty-odd radio-active elements, mesothorium, the first product of thorium, ranks next to radium in importance, states the author. Like radium, its disintegration products emit the three types of radiation that are characteristic of radio-active substances and that are known as alpha, beta and gamma rays. Mesothorium decays at least 250 times faster than radium, and hence in the pure state its activity, weight for weight, would greatly exceed that of radium. Although itself rayless, its first product, which is rapidly formed after mesothorium has been separated, gives a powerful beta and gamma radiation; the alpha radiation of freshly prepared radium attains a maximum within a month, whereas that of mesothorium increases comparatively slowly, and reaches its highest point during the fifth year after separation. Mesothorium preparations therefore must be "aged" before their full alpha-ray effect is realized in luminous products.

During the first years of separation, notwithstanding the comparatively rapid decay of mesothorium, its preparations maintain a higher gamma-ray activity than an equivalent quantity of radium. Mesothorium may thus serve as a substitute for radium, both in luminous compounds of radium and for therapeutic purposes.

Uranium ores, especially carnotite, are worked primarily for the extraction of radium—uranium, vanadium, etc., being secondary products. Mesothorium, on the other hand, is obtained as a secondary product or a by-product in the manufacture of thorium for the gas-mantle industry, its output being governed by the demand for thorium nitrate.

For a good many years the production of mesothorium in Germany, and to some extent in other countries in Europe, has kept pace with the production of radium. The Germans early recognized the value of mesothorium as a substitute for radium, not only for luminous paint but also for medical purposes. Only during the last two or three years, however, has production taken place in this country. Two companies have been recovering mesothorium as a by-product in the extraction of thorium. The Bureau of Mines has had a cooperative agreement with one of these companies. Very little has been published concerning the recovery of mesothorium. Methods of measurement have been uncertain and somewhat difficult, and Dr. Schlund's paper is intended as a contribution to the chemistry of this useful and interesting element.

Experiments of the Bureau of Mines in determining the ratio of mesothorium to thorium by direct comparison of gamma activity with radium are described in this paper.

## WOULD REQUIRE PEDESTRIANS TO SIGNAL AUTO TRAFFIC

*Science Service*

SIGNALS by pedestrians to show automobile drivers their street crossing intentions were proposed here to-day by Dr. Raymond Dodge, chairman of the psychology section of the National Research Council, as a means of making city traffic more safe.

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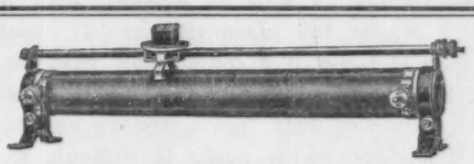

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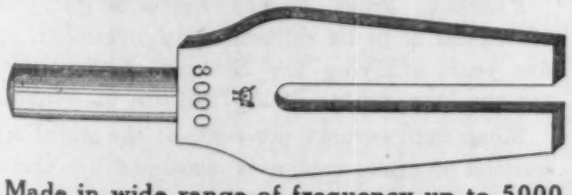


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"It is often quite impossible for a driver to determine when a pedestrian is going to start across the street, when he is going to retreat, or what direction he is going to take," Dr. Dodge said, and suggested that it would be a great help to drivers if pedestrians were required to indicate their intentions in some such way as the chauffeur is required to do in making turns.

"A simple scheme for the most desirable starting time and duration of signals can be worked out by any psychologist who knows the limitations of attention and reaction-time and will familiarize himself with the traffic situation.

"It is possible that there also ought to be tests for pedestrians as well as drivers, with distinguishing marks for incompetents. It would be some help if the driver could know that the man trying to cross the street was partially paralyzed, partially blind or deaf, had a wooden leg, or some other disability which made it difficult to take care of what he had left. As it is now, youth and old age are the only clearly marked incompetents.

Much has already been done to diminish the sources of confusion, such as the introduction of traffic signals and the establishment of zones or islands of safety where pedestrians can take their problems in smaller doses. But, if I am correctly informed, a systematic analysis of confusion of pedestrians or drivers has yet to be made. Such a study would involve the practical limits of attention and the facts of human variability. The sudden appearance of an unheralded vehicle coming around the corner, the convergence of vehicles on a pedestrian and even the blatant automobile horns themselves are worth considering as sources of confusion.

"Advantages would be derived from one-way traffic. Confusion would be diminished by uniformity of traffic rules, and signals, by better lighting of cars, and a better system of street lighting. Most street lighting involves decrease of the visual acuity by glare. Pedestrians should also have training in time and space estimation.

In addition to the possible services of psychology in the regulation of the highway, there is undoubtedly need for the services of expert educationalists," Dr. Dodge said. "The pedestrian must be trained as well as the driver of motor vehicles and the proper place for that training is in the school. It seems reasonable to suppose that one of the most important school functions in fitting the child for his environment is the ability to take care of himself on the highway. This task can be undertaken only when the regulations of the highways have reached a point where it is uniform in all the states and uniformity should only be aimed at when we are sure that from the standpoint of space and time as well as from the standpoint of the human mind the proposed regulations have been thoroughly scrutinized and revised."

"Newspaper and movie campaigns by cartoons, advice and stories," Dr. Dodge added, "should be continuous and not limited to one week in the year."

## SCIENCE ITEMS

*Science Service*

SCIENTISTS, government officials, fruit growers and nurserymen met in Washington on November 20 to discuss means of checking the latest Japanese invasion to gain a foothold in this country. The camphor scale, a newly discovered crop insect pest, is spreading rapidly among camphor, satsuma orange, olive, privet, Japanese persimmon, fig, plum and pecan trees in Louisiana and Alabama. Drastic measures to prevent the spread into other states were suggested as the experts gathered. The insect has been traced to an importation of satsuma orange trees direct from Japan just before the plant quarantine barriers were put up in 1911-12. This scale has been classed as a menace with the Japanese beetle, the European corn-borer and the pink boll worm, which gained a footing about the same time. A federal quarantine on the two states invaded to protect the other citrus-growing regions of the country from attack by prohibiting the movement of nursery stock and other articles likely to carry the pest is being considered.

ONE DOLLAR from each of the Knights of Pythias, $1,000,000 in all, has been donated by the Supreme Lodge of that order for benefit work among the lepers of Culion Island and to carry on the search for an absolute cure for that dread disease. Part of this fund will be used in the erection of a fully equipped experimental laboratory.

PASTEUR, great French bacteriologist, whose centennial is to be celebrated in December, spent five years studying the diseases of the silkworm for the Department of Agriculture of France.

MORE than seventy per cent. of the world's production of crude rubber is consumed by American rubber manufacturers.

ALGERIAN sheep are comparatively immune to anthrax, while all other sheep seem extremely susceptible to it.

# SCIENCE NEWS

## DR. LANGMUIR ON ELECTRON EMISSION

RECENT discoveries in electron emission and current-control were described in a series of three lectures by Dr. Irving Langmuir at Carnegie Institute of Technology, Pittsburgh, on November 27, 28 and 29. Dr. Langmuir's auditors during the series were scientists, engineers, industrial executives and students of Carnegie Tech, and his world-wide reputation as a research physicist with the General Electric Laboratories at Schenectady attracted capacity audiences. Synopses of Dr. Langmuir's three lectures follow:

### ELECTRON EMISSION FROM HEATED METALS

When metals are heated in high vacuum, electron, or atoms of negative electricity, evaporate from their surface. If there is another electrode in the evacuated space which is given a positive charge the electrons drift over to this electrode (anode) so that a current flows between the two electrodes. Dushman has recently derived an equation which should supersede the well-known Richardson equation, giving the relation between the electron current and the temperature of the cathode. The advantage of this new equation is that there is only one constant which we need to know for each different cathode material, instead of two constants which were necessary for the Richardson equation.

The electron emission from a large number of different materials has recently been measured. The thoriated tungsten cathode gives a current at a temperature of 1,500° absolute, which is about 130,000 times greater than that from ordinary tungsten. Measurements have also been made of cathode materials that have even much greater emissions.

In order to get all the current that a cathode is capable of giving, it is necessary to apply to the anode a high enough voltage to overcome what is known as the space charge effect. By putting in gases positive ions are formed in the space between the electrodes, and these neutralize the negative space charge and allow the current from the cathode to pass across the space with much lower anode voltages. In other words, the effect of gases is to increase the current-carrying capacity of the two. Such an effect is used in the Tungar rectifier. Care must be taken what gas is used for the purpose, for many gases have the effect of poisoning the cathode, and cutting down its emission to a small value.

If very high voltages are used on the anode, so as to produce intense electric fields, it is possible to pull electrons out of the cathode. In fact, it is possible to pull electrons even out of cold cathodes, that is, cathodes at ordinary temperatures. The currents obtained this way from the cathode come from very minute areas, but in these areas the current density amounts to more than one hundred million amperes per square inch.

### ELECTRON EMISSION FROM THORIATED FILAMENTS

The thoriated tungsten filament is a tungsten filament containing one or two per cent. of thorium, usually in the form of oxide. When such a filament is heated, to about 3,500° Centigrade, a little of the thorium oxide is changed into metallic thorium. In the meantime, however, any thorium on the surface of the filament evaporates off, leaving only pure tungsten. If the filament temperature is then lowered to about 1,800°, the thorium gradually wanders or diffuses through the filament, and when it reaches the surface, if the vacuum is very perfect, remains there and gradually forms a layer of thorium atoms which never exceeds a single atom in thickness. The thickness of this film is therefore about 1/100,000,000 of an inch, and yet this film increases the electron emission of the filament more than one hundred thousand fold.

Of course this useful film is very sensitive and needs some protection to keep it in good condition. Very slight traces of water vapor or other gases would oxidize this film and destroy it. This can be avoided by putting in the bulb some substance that will combine with the water before this has a chance to attack the thorium film. Such a substance is metallic magnesium. Furthermore, it is necessary to avoid heating the filament to too high a temperature for otherwise the film might evaporate off. It is therefore best to operate such filament within a rather narrow range of temperature close to 1,700° C., where the ratio of evaporation is very small, and where the temperature is high enough for the thorium gradually to diffuse to the surface and continually repair any damage done by the effect of slight traces of residual gases.

The thoriated tungsten filament opens up many new fields of scientific investigation. By measur-

ing the electron currents, it is possible to determine accurately exactly how much thorium is present on the surface. An amount of thorium corresponding to only 1/1000 of the surface covered with a layer one atom deep is easily measurable in this way. It is possible to knock off a thorium film by bombarding it with positive ions, moving at high velocities, and in this way the true nature of this bombardment can be determined.

METHODS OF CONTROLLING ELECTRON CURRENTS IN HIGH VACUUM

Most of the applications of high vacuum tubes have depended upon the control of electron currents, as, for example, by the grid in the three electrode tube. The action of the grid is due to the charge on the grid modifying the space charge effect. This is the action that is employed in practically all tubes used to-day for radio transmission and receiving. There are many other methods, however, of controlling electron currents. A very important method is that used in the magneton, where there are only two electrodes in the evacuated space and the control is obtained by means of a magnetic field generated by an external coil of wire. A still simpler form of magneton suitable particularly to very large power tubes, consists of a very large filament in the axis of a cylindical anode with very large straight filaments. The magnetic field produced by the current through the filament is enough to prevent electrons flowing between cathode and anode. By heating the filament with alternating current, the current periodically falls to low value and at these times current can flow to the anode. This gives a pulsating or oscillating current, which can be used for radio transmission. A 1,000 kilowatt tube of this kind is in process of development; preliminary tests have been in every way satisfactory.

Another form of tube by which electron currents can be controlled is the Dynatron. This depends upon subjecting one of the three electrodes in the tube to electron bombardment in such a way as to cause electrons to be splashed out of it, just as water can be splashed out of a cup by attempting to fill it too rapidly from a faucet. A tube of this kind acts like a real negative resistance, and can be used for producing electrical oscillations with considerable efficiency.

One of the most important applications of electron discharges from hot cathodes is in the Coolidge X-ray tube which is now almost universally used as a source of X-rays. These tubes were first made about 1913 and are gradually being improved in many respects. The latest type of tube, suitable for use by dentists, is a small tube weighing only a few ounces, and only about three inches long. Because of the special features of this tube, the entire X-ray outfit, including the transformer, lead screen, regulating apparatus, etc., weighs only a few pounds and takes up a space of only a small fraction of a cubic foot. One very great advantage of this new form of tube, besides its convenience, is its absolute safety, even in the hands of inexperienced operators, for there are no high voltages in any part of the apparatus which is accessible.

## EYE HOLDS SECRET OF TRAFFIC SAFETY

*Science Service*

A "LOOK-ONE-WAY" traffic system as a preventive of many of the frightful automobile accidents of America's deadly streets has been suggested by Dr. Raymond Dodge, authority on visual psychology and head of the psychological section of the National Research Council. Traffic signs, signals and routes should be determined according to a thoroughgoing study of what the human eye can see easiest.

"In the present regulaton of traffic, both driver and pedestrian never cover less than forty-five degrees of visual angle and may be required to look over an angle of over two hundred degrees. Such a range of vision is humanly impossible without moving the head from side to side. This always involves an interruption in the view of the part of the street from which trouble may come. One of the greatest dangers in crossing the street comes from vehicles that suddenly emerge from a side street.

"As a matter of safety there are grave doubts as to whether the present regulations that limit pedestrians to a narrow street crossing at exact intersections of streets is the best practicable solution. It may be more convenient for drivers, but the exact intersection of streets is most dangerous for pedestrians. Behind waiting cars is safer than in front of them. Twenty feet from a cross street would diminish the probability of being surprised by turning cars.

"Use of all parallel streets as one-way streets would be a great advantage. There is a slight but real difference between the sides of the street for pedestrians. It can be demonstrated that the left-hand sidewalk is safer. When the pedestrian is on the left sidewalk about to cross a street he has to watch only automobiles on his left and to the right of him, while a walker stepping off the right hand sidewalk across a street has to be alert

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**By SIMON H. GAGE of Cornell University**

13th Edition, Published December, 1920

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to possible danger on his left, to his left rear, and to his right. It is well known that the left hand side of the street should be used by pedestrians when there is no sidewalk.''

There is a very real and important problem with respect to the ideal construction of a traffic sign. How many words would be read in the available time? What would be the minimum size of letters? What should be the structure, place, color and content of signs? He contends that there is already a body of practical experience and scientific information available which would only need to be adapted to highway use and experimentally justified.

For instance, he said, it has been thoroughly demonstrated that adults do not read familiar words letter by letter but by familiar letter groups. Yet, here in Washington, we have signs reading ''Slo.'' Dr. Dodge said that when he first saw that strange sign it took him many times the effort and time to understand and interpret it that would have been sufficient for ''Slow.''

''The nature and time of hand and arm signals by automobile drivers should be also regulated. They are sometimes short, and sometimes long, sometimes early and sometimes late. The continuous indication of a driver's intentions beginning at least five seconds before a movement is executed and continuing until a movement is completed would be a great advantage.''

Traffic policemen should wear white sashes and trolley posts should be painted in alternate bands of white and black to increase their optical usefulness.

## PREDICTS WINTER WEATHER BY SUMMER-TIME TEMPERATURES

*Science Service*

FORECASTING the rainfall for the coming winter and spring from the past summer's ocean temperatures, Dr. Geo. F. McEwen has predicted that the Southern California coastal region will receive about one half inch less than its average rainfall during the season 1922-23. He suggested the possibility of applying the same system to predictions over more extensive areas. Dr. McEwen is neither a goose-bone prophet nor a crystal gazer, but the oceanographer connected with the Scripps Institution for Biological Research. He bases his system of forecasts on carefully worked out observations during the last six years.

These observations show that when the ocean temperature averages colder than usual the rainfall is heavier than usual and when the summer seas are warmer than the average the subsequent rainfall is smaller than the average rainfall. A fall of one degree in temperature corresponds on the average to an increase of about two inches in the rainfall.

Rainfall in the Southern California coastal region depends mainly upon the flow of the moisture-laden air from the Pacific and is proportional to the amount of the air transferred.

This in turn depends on the formation of a belt of high air pressure over the continent, he explains. In summer the barometric pressure is greater over the ocean than the land for two reasons. The wind velocity over the smooth water surface averages two or three times as great as that over the relatively uneven land and in summer the air flows from the land. But as the season advances to winter, air flows over the land from the water and carries a great mass of air from the Pacific Ocean to the North American continent.

Enough pressure measurements over the North Pacific on which to base predictions being unavailable, Dr. McEwen used the known relation between pressures and surface ocean temperatures. The velocity of the winds which move clock wise over the Pacific depends on the air pressure and the upwelling of cold bottom water along the coast and therefore the rate of cooling of the surface water is proportional to the wind velocity. The lower the ocean temperature at or near the surface during the late summer and autumn, he declares, the greater must be the intensity of the ocean belt of high air pressure and accordingly the greater will be the expected seasonal rainfall over the coastal region of Southern California.

When asked which days would be the rainy ones, Dr. Ewen explained that long range forecasting is only done at the sacrifice of details and for daily information he advised waiting for the regular government forecast issued twenty-four to forty-eight hours in advance.

Another example of successful long range forecasting is the prediction of the monsoon rainfall of India, months in advance, by means of observations on atmospheric pressure distributions over vast areas of land and water.

## ECLIPSE EXPEDITIONS IN AUSTRALIA

By Isabel M. Lewis, U. S. Naval Observatory

*Science Service*

NEVER have eclipse expeditions been favored with fairer skies than spread over the entire continent of Australia on the eventful day of the total solar eclipse of last September. From

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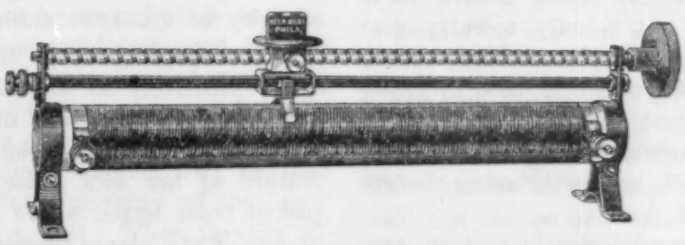

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Wallal on Ninety-Mile Beach in northwestern Australia to Goondiwindi and Stanthorpe in Queensland all forms of eclipse observations were made by a host of astronomers from many lands.

Shadow-bands, fleeting lunar shadow, a never-to-be-forgotten pearly coronal light, four, enormous, equatorial streamers, petal-formed and arched, a million and more miles in length, five brilliant planets and a star of first magnitude, Spica, near the sun, eclipse paraphernalia of all kinds and shapes manipulated by leading astronomers from many lands, even a governor in attendance, were features of this eclipse. And what more was to be desired to make a perfect success of a perfect eclipse day?

The most important feature of the eclipse from the astronomical point of view was the successful exposure of many photographic plates with astrographic telescopes at all points of observation in Australia. These plates, it is hoped, may reveal the slight displacements of the star-images from their normal positions known as the Einstein effect, due to the bending of light rays by the sun's gravitational field, which is a vital test of the Einstein theory.

At Wallal, where observations were made by Canadian astronomers, by an expedition from the Lick Observatory under Director W. W. Campbell, and by observers from New Zealand and various observatories in Australia, particular attention was given to this problem. Owing to the great clouds of dust that arose after totality was over it was impossible to develop the plates at Wallal and they were shipped to Broome, where they were developed later. The sailing of their ship made it necessary for the American astronomers to embark for home before these plates were developed. It is only recently that these developed plates arrived in the United States and the scientific world is now awaiting with the liveliest interest the announcement of the results of the measurements of these plates which it is hoped will be forthcoming before many days have passed.

Astronomers from observatories in eastern Australia who made observations at Goondiwindi and Stanthorpe, though enthusiastic about the eclipse as a scenic feature, deplore the fact that the "seeing," as astronomers call that state of the atmosphere that is such a vital factor in determining the value of observations, was particularly bad. As a result they are pessimistic as to the value of the measurements of the star-images that will be made on plates taken at these places. The eclipse occurred at these points in the late afternoon so the altitude of the sun was much lower than at Wallal where the eclipse occurred about 1:30 P.M. The effects of atmospheric refraction and other atmospheric disturbances were consequently more pronounced in eastern Australia than at Wallal. It is generally felt that the most valuable results will be the ones obtained from plates taken at Wallal, though Director Dodwell, of the Government Observatory at Adelaide, is said to have made some excellent observations at Cordillo Downs in central Australia.

Instruments were transported to this point from the railroad terminus by camel train, an arduous undertaking which took six weeks time. It is reported to have been attended with complete success, though no results of the reductions of plates in Australia are yet available.

## SCIENCE ITEMS

*Science Service*

A FARM which raises diamond-back terrapin for the market by thousands has been conducted for many years near Savannah, Georgia.

ELEVATOR screenings, which grain elevators have been paying to get rid of, have been successfully used to fatten sheep in Canada.

FORTY THOUSAND separate and distinct species of locusts, the historic pests which annually cost the world about $100,000,000 have been identified and collected by American scientists.

THE reddish color of Mars is supposed to be due to great stretches of desert on that planet.

THE ZR-1, the airship now being built for the U. S. Navy, will be 680 feet long, 78 feet in diameter, and have twenty gas bags with a total capacity of 2,155,200 cubic feet.

BY making synthetic thymol, a drug that is used extensively as an antiseptic and a specific against the hookworm disease, Department of Agriculture chemists have again vanquished Nature at her own game. Thymol is now imported from India, where it is found in the seed of one of the plants growing there. The chemists have found that artificial thymol identical with the natural product can be made from cymene, a waste product in the paper industry. Thymol is now sold for $4.50 a pound, but it is estimated that the synthetic product can be made for about $2.50 a pound. As there are 2,000,000 gallons of cymene wasted annually in this country and Canada, chemists expect that this country will soon be able to produce all the thymol consumed here.

# SCIENCE NEWS

## THE PSYCHOLOGY OF AUTO DRIVERS

*Science Service*

NATION-WIDE standardized mental tests for auto drivers to determine the kind of machine each individual shall be permitted to run is the plan for cutting down our alarming motor-car accident toll urged by Dr. Raymond Dodge, professor of psychology in Wesleyan University, and this year chairman of the division of psychology of the National Research Council.

"All persons are not equally suited to driving a car," he said. "One man in an emergency gets and acts on an idea quickly, another slowly. The time that elapses after a danger is seen until the driver can start the movement that is required to avoid it is an important factor in safety. Slow and uncertain or wavering actions are undoubtedly the occasion of many accidents. This slowness is in part due to lack of practice and training and in part due to the natural tendencies of the individual. Both of these factors can be made matters of test."

"The natural speed with which a person acts, his 'reaction time' can be easily measured and the relative ability of chauffeurs in this respect could be determined," Dr. Dodge explained. "The time that it takes for a signal to reach the eye, be transmitted to the brain, and for the brain to send its order down through the nerves of the arm seems instantaneous, but it can be measured by the reaction time test used in our psychological laboratories every day. A person is seated at a table with his finger on a telegraph key. As soon as he sees a given signal he presses the key. When the signal flashes, the electric current also starts a pointer marking off the fractions of a second upon a dial. When the key is pressed the current is broken and the hand on the dial stops moving. This gives a record of the time it took the person to get and act upon the idea."

"Tests for driving ability," he continued, "should be varied according to the sort of tasks which the drivers are called upon to perform. Tests for drivers of light, pleasure vehicles might be very different from tests for drivers of fast ambulances and fire appliances, and they in turn might be quite different from tests for drivers of heavy motor trucks. High powered fast machines obviously should not be entrusted to poor or relatively untrained chauffeurs. A specific form of test for various types of machines is good common sense and good science.

"In addition to tests for mechanical expertness, knowledge of traffic regulations and automobile limitations should also be required."

Jailing reckless drivers and requiring speeders to view accident victims in the morgue are haphazard methods. Licenses to drive should not be issued to persons with such tendencies to motor manslaughter. It is perfectly possible that the psychologists will be able to work out tests to determine the moral tendencies and regard for common interests of applicants for driver's licenses.

"Careful analysis and expert thoroughgoing experimental investigation of these and other problems involving the mental processes of those who use the highways should be made," Dr. Dodge emphasized. "When there has been a systematic exploration of the human factor in traffic, tests can be standardized.

"It is notorious that tests for drivers in one community are entirely different from tests in other communities. Licenses from different localities are quite incomparable in value. It is obvious that the same ability to drive is not required on a country road as in the city, but if the farmer is to drive into town, he must be able to handle his machine under city traffic conditions or else not be allowed to come in. Standard tests would help remedy this situation.

"Even now we should have a national blacklist for chauffeurs so that those who have forfeited their licenses on account of bad driving in one state can not go over into another state and continue their homicidal practices."

## CHRISTMAS TREES OLD IN LEGEND AND EVOLUTION

*Science Service*

CHRISTMAS trees, as a family, are of the oldest of our trees to-day. For reasons connected with their antiquity, experts of the U. S. Forest Service say that these evergreens have become so popular for Yule-tide decorations that between four and five million trees are consumed in this country every year, while plantations which raise Christ-

mas trees as a farm crop are springing up to help supply the future demand.

These conifers or cone-bearing trees that hold the bright gifts and cheerful tinsel of this religious festival and winter holiday were the earliest of trees, and their direct ancestors were the first flowering plants on earth. They probably originated during a period of rigorous climate and their thin needle-leaves present less surface to cold and exposure than the broad-leaved trees which represent a later stage in plant evolution.

And these needles are probably responsible for the use of the conifers as Christmas trees. They present only a small surface to the effect of evaporation and so enable the tree to retain its moisture and keep green. This greenness added a touch of life to the dullness of winter and made the evergreens popular as decorations. Legends and custom did the rest.

There are many kinds of these evergreens, but the principal ones used for Christmas trees in various parts of the United States are the pines, spruces, firs and cedars. If you do not know what kind of a tree it is that bears your gifts, you can easily tell by looking at the needles on the branches. In the pines, the needles grow in bunches of from one to five needles to the bunch. If the individual needles in these bunches are pressed together they form a complete cylinder. Some kinds of pine have two needles to the bunch, but these two are each half cylinders, while in those having three needle bunches the three needles form a cylinder, and so on.

If the tree is a fir, the needles grow out from the two sides of the stem, while in the spruce the needles grow out in all diretions around the stems. In the cedar, the needles are like little twigs pressed compactly together in a sort of shingle-like formation.

Joy-killers frequently arise and bewail the cutting of these trees for Christmas use as wasteful. But aside from the joy they bring the kiddies, U. S. Forest Service officials believe that properly done the cutting of Christmas trees can really be made a Christmas gift to the forests themselves.

In Maine and the Adirondacks, the principal localities that supply Christmas trees, there are frequently as many as 50,000 to 100,000 seedlings to the acre. Few of these can reach maturity. It is essential for the production of tall, clean timber that there should be at the beginning many trees to the acre, but unless these are thinned out, the poorer trees may hamper the development of the better ones.

Man, by interfering in the struggle and thinning out of all lagging trees, can hasten the growth of the remaining trees. In many localities, this work depends on the possibility of finding a market for the small trees to pay for the cost of the thinning, and the Christmas market solves the problem.

In Michigan, however, the state agricultural station several years ago started raising Christmas trees as a farm crop. They have just issued information telling how this can be done commercially and encouraging farmers to plant for this purpose.

## WAITING FOR TREE PLANTERS

*New York State College of Forestry*

EVERY home owner in New York State is paying heavy freight on the lumber of which his house is made. Every lessee of an apartment or dwelling is paying in rent large amounts for freight on the lumber used in the construction of the building in which he lives, according to the New York State College of Forestry at Syracuse University. The people of the Empire State—relative figures apply to all the eastern states—are taxed for freight approximately $22 a thousand on yellow pine, $27 on Douglas fir, $12 on North Carolina pine, $12 on white pine, and $20 on imported hardwoods. The freight rate on Douglas fir which comes from the Pacific Coast is more than the lumber costs at the mill.

Thirty-five million dollars are taken from the pockets of the citizens of New York every year for freight on imported lumber. In addition to this freight bill of $35,000,000 on lumber must be added the cost of shipping 55 per cent. of our pulpwood into the state from Canada and other points. The transportation costs are bound to grow as the depletion of the nearest lumber and wood supply continues and the demand increases.

Much of the lumber consumed in the east is shipped from the south. It is estimated that in the course of ten to fifteen years the southern field will be exhausted insofar as outside consumption is concerned. Then Oregon, Washington and California will have a practical monopoly of the lumber business which will bring about materially increased freight charges to eastern consumers.

Measures should be taken to overcome this condition as far as it is now possible. A large portion of the lumber and other wood products used in New York could and should be grown within the state, and forests should be planted wherever land is suitable for that purpose. More than

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4,000,000 acres of idle land in New York and about 85,000,000 acres in the United States (a tract about as large as New York, Pennsylvania, Rhode Island, Connecticut and New Jersey) are waiting for tree planters.

## THE SPEED OF STARS

*Science Service*

TWO HUNDRED miles a second is the speed at which some stars are racing through space, Dr. Walter S. Adams, acting director of the Mount Wilson Observatory, declared in a lecture at the Carnegie Institution of Washington.

The rapidity with which the stars move depends upon their stage of development, their true or intrinsic brightness and probably their mass. The giant stars are moving more slowly than the dwarf stars and the increase of velocity with decreasing mass is a regular one. But these individual stars, he pointed out, are not moving at random. They move in great streams and the speedway of the heavens is in the plane of the Milky Way.

"None of the rapidly moving stars are going in the same direction as our sun," he said. "The speed of the sun is about twelve miles a second when referred to the slowly moving stars and over one hundred miles a second with reference to the exceptionally speedy stars.

"From a knowledge of the spectrum of stars we have been able in the past to learn both their chemical constitution and order of evolution as regards temperature and physical state, and their motions toward or away from the earth in miles a second. In recent years we have been able to add a third use to which the spectrum may be put, and we can now determine the true or intrinsic brightness of a star directly. This quantity combined with a knowledge of its brightness as it appears to us enables us to determine its distance in a very simple manner."

The method has nearly tripled the number of stars for which we know the distances, Dr. Adams said, and a knowledge of the distances has made it possible to determine the true motions of these stars in space.

## FLYING CHEAP TRAVEL

*Science Service*

IF airplanes could get enough business, passengers could be carried much more quickly at little greater cost than by railroad, Archibald Black, aeronautical engineer of Garden City, N. Y., told the American Society of Mechanical Engineers while discussing the proper design for commercial flying machines. "For example, the distance from New York to Chicago by the Pennsylvania Railroad is 908 miles, or a flying distance of from 750 to 800 miles," he said. "Were it possible to load the airplane fully each trip, the operating cost would be 6.5 cents per passenger mile or $48.75 to $52 per passenger. This compares with the railroad rate of $51.30, including fare, excess fare and Pullman. Allowing for the trip to and from the fields, as well as an intermediate stop, the time by air would average about nine hours as against twenty hours by the Pennsylvania Railroad's 'Broadway Limited.' The only reason why airplanes can not carry passengers at such rates to-day is that it costs too much to get the business."

Moderate size machines only, he emphasized, could be efficiently operated at this low cost and the requirement of ability to fly on one of two engines is utterly impractical for commercial airplanes because of the prohibitive cost. The commercial plane should be designed for jumps lasting not over four hours, while high speed is undesirable and high climbing ability unnecessary and impractical for the commercial craft.

## A MARVELLOUS ARCHEOLOGICAL DISCOVERY

*London Times*

THE earth holds in her recesses the rich memories of our race, and sometimes, as though the effort of the reflective and inquiring mind of modern man had suddenly flashed forth in a revealing intuition, a discovery comes that lights up the obscurity of the distant past. One such discovery we are privileged to record to-day. Our Cairo correspondent tells us how, after sixteen years of patient toil and research, Lord Carnarvon and that distinguished excavator, Mr. Howard Carter, have been rewarded by a marvelous find in the Valley of the Kings near Thebes. All the mysteries of this famous valley had been disclosed, so it was thought, long since. Mr. Carter, with the pertinacity of the gifted archeologist who scents discoveries from afar, dug on persistently until at last, in the royal necropolis of the Theban empire, he came across some tempting signs below the tomb of Rameses VI. Lord Carnarvon went out from England, and he and Mr. Carter together opened the sealed doors of a hitherto unnoticed chamber. When opened this chamber revealed an amazing spectacle. There were gilt couches, inlaid with ivory and precious stones; innumerable boxes, inlaid and painted with entrancing hunting scenes; a wonderful throne; a chair encrusted with precious stones and

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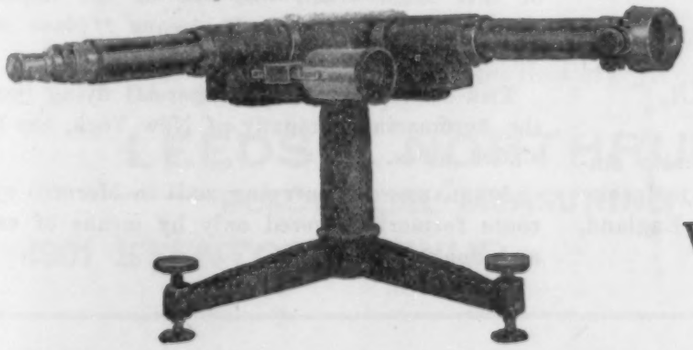

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adorned with royal portraits; bituminized statues of a king, chariots, maces, a footstool, alabaster vases, and quantities of trussed duck and haunches of venison, left, according to the ancient custom, as provision for the great dead. Beyond the first chamber lay another chamber crowded with a confusion of gold beds, boxes and alabaster vases, and beyond this, again, lies another chamber which may prove to be the actual tomb of the king whose funeral relics lie in bewildering profusion in the first two rooms. The name of the king who thus emerges in splendor from the dim past into the murky light of our troubled day is Tutankhamen, of the Eighteenth Dynasty, who reigned in Tel-el Amarna and Thebes over three thousand years ago. Little was known of him except that he claimed to be a son of the famous Amenhotep III, and that he married the daughter of that strange Pharaoh Akhenaten, who revolutionized the Egyptian religion by instituting in the worship of the rays of the sun a kind of monotheism, and at the same time promoted a remarkable artistic revival. Of Tutankhamen the chief fact hitherto attested is that in his reign the traditional religion, with its worship of Amen as the principal deity, once more claimed its own. He was, so to speak, the patron of a counter-reformation. Now, thanks to this remarkable discovery, we may perhaps learn more of the circumstances of this strange ebb and flow of religious emotion in the days when mankind was still young. And though the world is old now and restless still, with the craving for power and for a knowledge of great mysteries, even now when the eastern lands are trembling between war and peace and a Europe undreamed of by the Pharaohs is wrestling with problems that would have been stranger to them than all their weird panoply is to us, that figure of the ancient king who thus suddenly steps out from oblivion has a permanent significance. On his footstool are figures symbolizing his lordship over Syria, and the peoples of Ethiopia owned his sway. Around him are the confused tokens of a reversion from a groping after new spiritual ideas to the comfortable forms of an ancient ritual.

## PRELIMINARY TRANS-ATLANTIC RADIO AMATEUR TESTS SUCCESSFUL

*Science Service*

MESSAGES broadcasted by amateur radio stations in preliminary trans-Atlantic tests just completed were received across the water in England, reports from that country say.

For ten days on predetermined schedules, amateur radio enthusiasts in all parts of Canada and the United States competed in order to qualify for a special place in the final trans-Atlantic tests that will be held between December 12 and 31. To qualify they had to be heard by a station at least 1,200 air miles away. Indications are that many will compete in the final tests.

The way in which the amateurs in the different radio districts kept within their allotted times was gratifying, according to officials of the American Radio Relay League who are managing the tests.

At least 20,000 radio amateurs are competing in these tests, it is estimated.

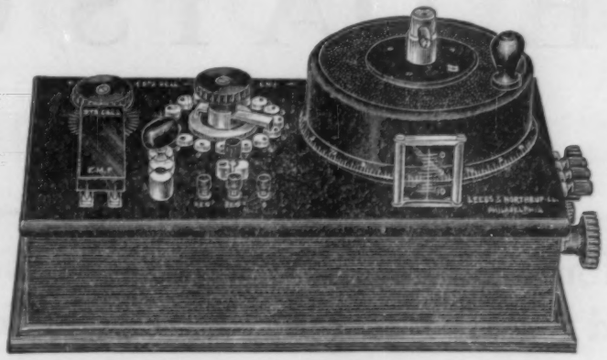
## ITEMS

*Science Service*

WORDS from a language which flourished centuries before Columbus are being used for names of varieties of the fruit, avocado or "alligator-pear," which is relatively new to this country. The U. S. Department of Agriculture has introduced Mayan names along with this salad-making fruit that its experts have brought from Guatemala, where centuries ago an ancient civilization flourished. Some folks seeing certain kinds of "alligator pears" taged "Itzamna," "Lamat," "Hunapuh," "Kayab," "Mayapan" and others equally strange, may have thought that the government has enlisted the services of the namer of Pullman cars. It has just been explained by the department that these names are taken from the Maya who built up in what are now the wilds of Guatemala great cities and a powerful agricultural civilization hundreds of years before Columbus ever left the old world. The avocado called "Itzama" is named after the chief Mayan god, the creator of mankind and the father of all the other gods. Such names as "Lamat" and "Hunapuh" designated days in the wonderful calendar of these ancient people, who had invented a system of chronology more accurate than the time systems of the Europeans of their time. "Mayapan," the name given to another variety of this salad fruit, was one of the important cities of this people. It means "place where there are Mayas."

THE *Santa Maria*, a commercial flying boat of the Aeromarine Company of New York, has flown 45,000 miles.

AIRPLANES are carrying mail in Morocco over a route formerly covered only by means of camels and donkeys.



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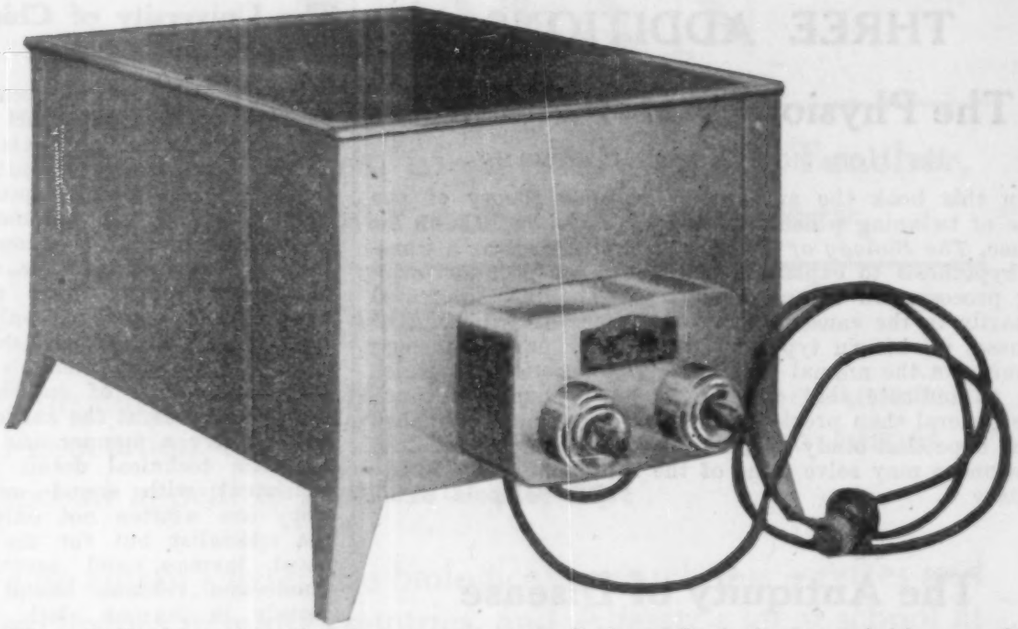

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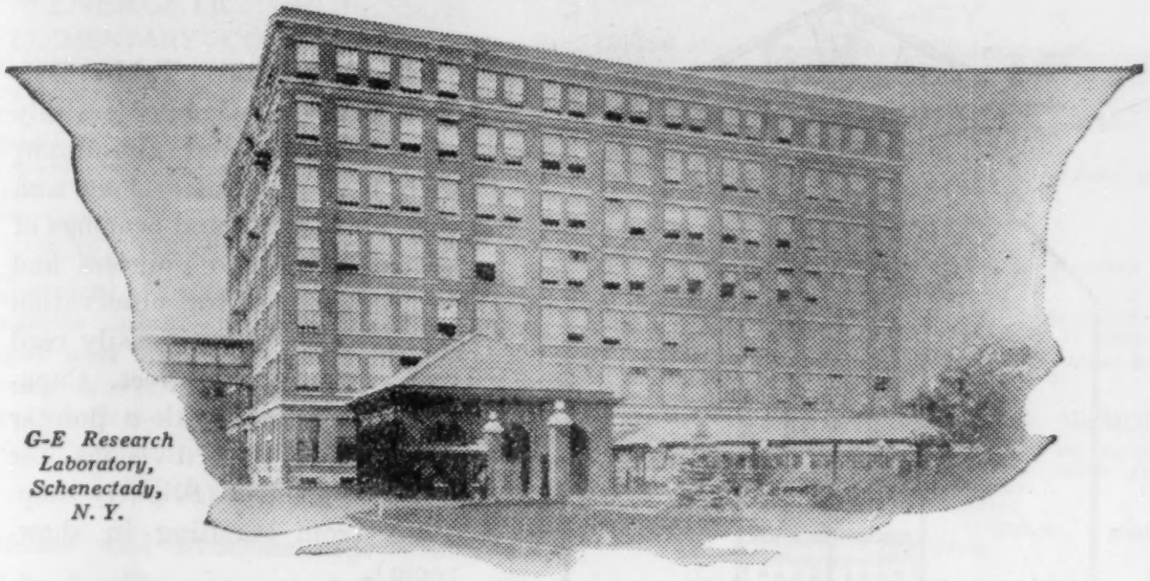

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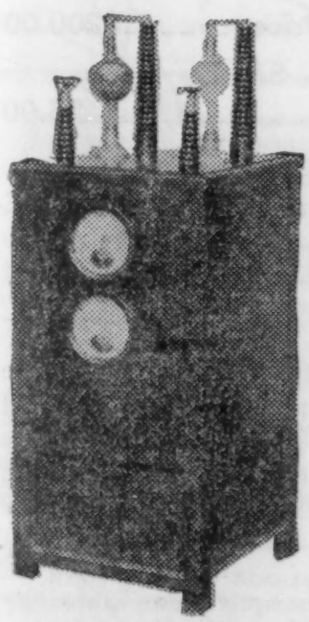

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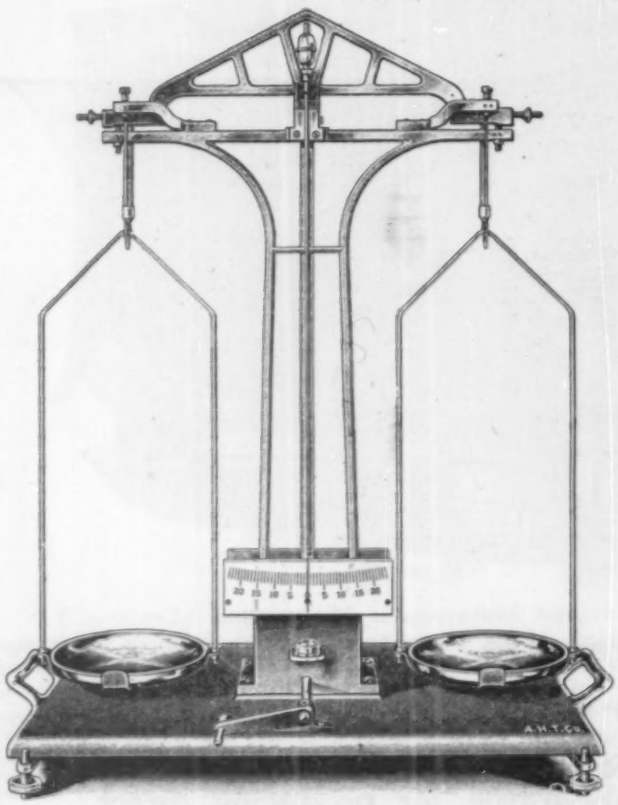

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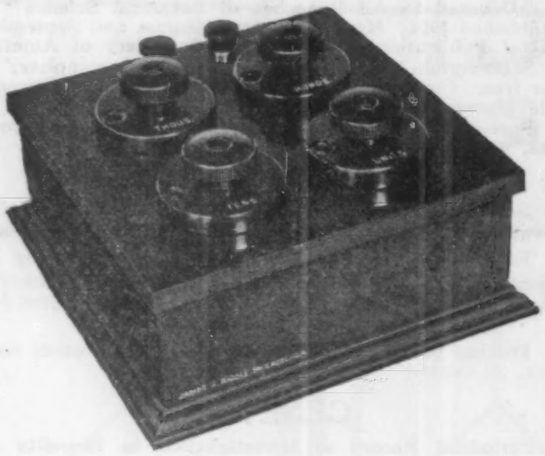

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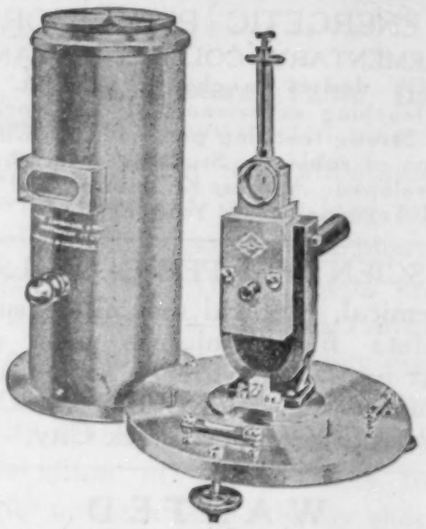

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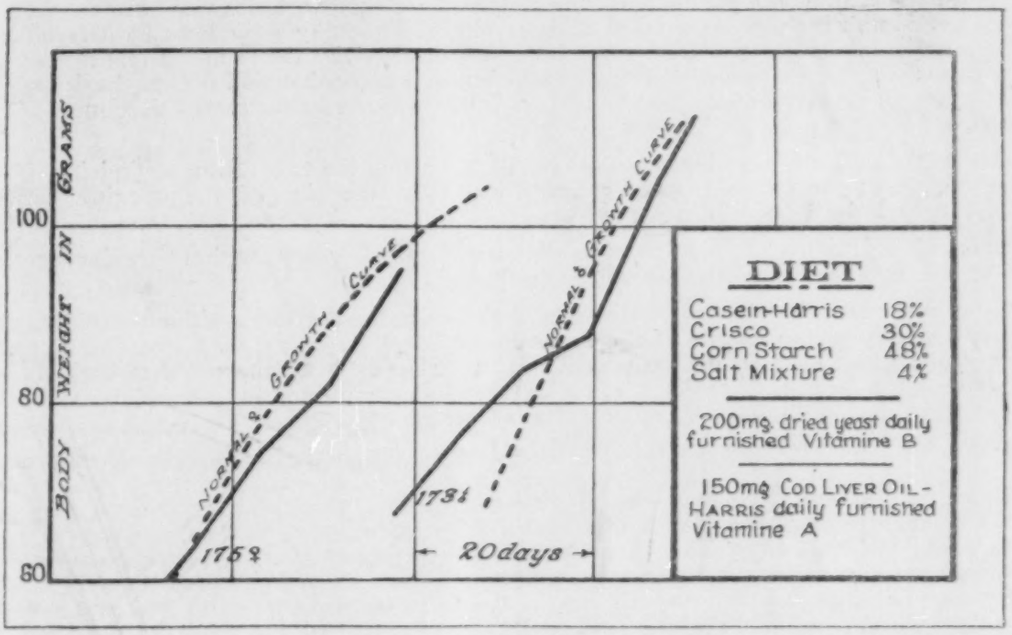


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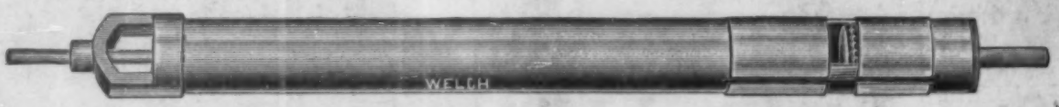


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